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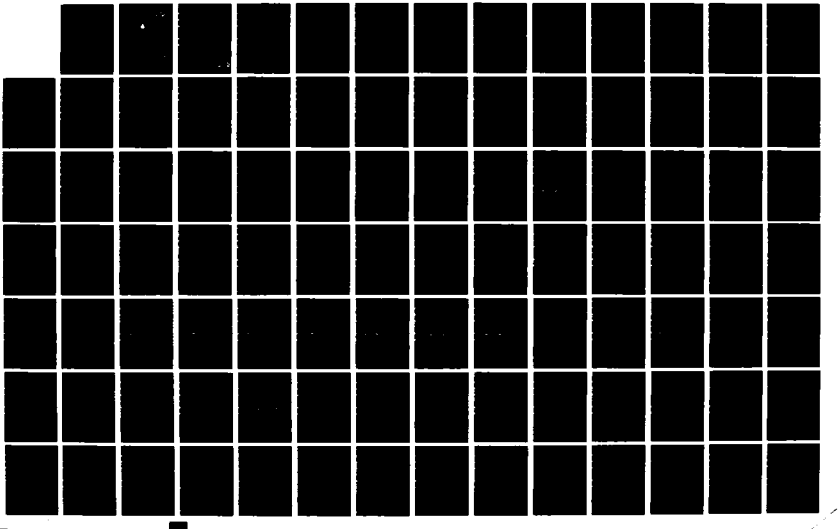

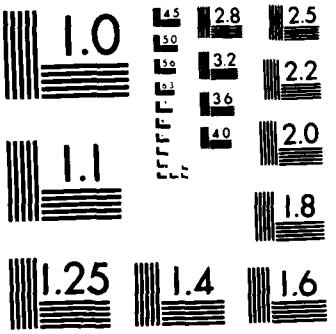

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Woods Hole Oceanographic Institution

A Compilation of Moored Current Meter and Wind Recorder Data

Volume XXXV Long-Term Upper Ocean Study (LOTUS)

(Moorings 764, 765, 766, 767, 770)

May 1982 - April 1983

by

Susan A. Tarbell
Nancy J. Pennington
Melbourne G. Briscoe

August 1984

Technical Report

Funding was provided by the Office of Naval Research under Contract No. N00014-76-C-0197, NR 083-400 and N00014-84-C-0134, NR 083-400.

Approved for public release; distribution unlimited.

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Approved for Distribution:

N. P. Fofonoff
Nick P. Fofonoff, Chairman
Department of Physical Oceanography

Abstract

LOTUS was a two-year experiment near 34°N, 70°W, designed to acquire and analyse a continuous set of measurements of currents and temperatures in the upper, open ocean together with local hydrography, meteorology, and mesoscale oceanographic features. The first scientific moorings were deployed in May 1982. The first year of mooring data, from May 1982-April 1983, is presented here.

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PREFACE

This volume is the thirty-fifth in a series of Data Reports presenting mooring current meter and associated data collected by the WHOI Buoy Group.

Volumes I-XVI present data prior to 1976 and are not listed below.

Volumes XVII through XXXIV present data obtained during the years 1972-1984, either by year or experiment (see notes).

A data directory and bibliography for the years 1963-1978 has been published, as WHOI Technical Report 79-88.

Volume XXXV presents data from the first year of the two-year Long-Term Upper-Ocean Study (LOTUS), namely May 1982-April 1983.

Volume No.	WHOI Ref. No.		Notes Year Experiment
XVII	78-49	Tarbell, S., A. Spencer and R. E. Payne	1975-1977 POLYMODE Array II
XVIII	79-65	Tarbell, S., M. G. Briscoe and R. A. Weller	1978 JASIN
XIX	79-34	Spencer, A., C. Mills and R. Payne	1974-1975 POLYMODE Array I
XX	79-56	Spencer, A.	1974 Rise Array
XXI	79-85	Mills, C. and P. Rhines	1978 W.B.U.C.
XXII	79-87	Tarbell, S. and R. Payne	1973 measurements
XXIII	80-40	Tarbell, S. and R. Payne	1978 POLYMODE Array III
XXIV	80-41	Spencer, A., K. O'Neill and J. Luyten	1976 INDEX
XXV	81-12	Spencer, A., E. D'Asaro and L. Armi	1977 B.B.L. Expt.
XXVI	81-45	Chausse, D. and R. Payne	1972 measurements
XXVII	81-68	McKee, T., E. Francis and N. Hogg	1975,76,78 topographic Expts.
XXVIII	81-73	Mills, C., S. Tarbell, W. B. Owens and R. Payne	1978 L.D.E.
XXIX	82-16	Levy, E., A. Spencer. G. Needell, G. Hund, and J. R. Luyten	1979 INDEX
XXX	82-43	Levy, E., S. A. Tarbell, N. P. Fofonoff	1979-1980 GSE/NSOI
XXXI	83-30	Levy, E. and S. A. Tarbell	1980-1982 WesPac
XXXII	83-46	Levy, E.	1979-1980 Vema Channel
XXXIII	84-6	Spencer, A., D. Chausse, and W. Owens	1981-1982 N. Pacific Boundary Current
XXXIV	84-16	Levy, E. and P. L. Richardson	1983, Atlantic North Equatorial Counter-current

LOTUS-related WHOI Technical Reports.

PRESENTLY AVAILABLE REPORTS

Title	WHOI No.	Date
Long Term Upper Ocean Study (LOTUS) A Summary of the Historical Data and Engineering Test Data.	82-53	Dec 82
The Long Term Upper Ocean Study (LOTUS) Cruise Summary and Hydrographic Data Report, OCEANUS 119 - May 1982.	83-7	Feb 83
The Long Term Upper Ocean Study (LOTUS) Cruise Summary and Hydrographic Data Report, OCEANUS 129, Oct 1982.	83-29	Aug 83
Long Term Upper Ocean Study (LOTUS) at 34°N, 70°W Meteorological Sensors, Data, and Heat Fluxes for May-October 1982 (LOTUS-3 and LOTUS-4).	83-32	Sept 83
The Long Term Upper Ocean Study (LOTUS) Cruise Summary and Hydrographic Data Report, ENDEAVOR 97, April 1983.	83-33	Oct 83
The Long Term Upper Ocean Study (LOTUS) Cruise Summary and Hydrographic Data Report, OCEANUS 141, November 1983, and OCEANUS 145, January 1984.	84-26	June 84
Current meter data report, LOTUS-3 and 4.	84-36	Aug 84

PLANNED FUTURE REPORTS

Subject	Expected Availability
Meteorological data report, LOTUS-5 and LOTUS-6.	Fall 84
Cruise summary and hydrographic data report, May 84.	Fall 84
Current meter data report, LOTUS-5 and 6.	Fall 84
A summary of the LOTUS experiment.	Winter 85

ACKNOWLEDGMENTS

The Long Term Upper Ocean Study (LOTUS) has required the interest and help of almost everyone connected with the Buoy Group, since its inception in 1979. We especially wish to thank the mooring engineering effort, led by Bob Walden, the instrument engineering effort, led by Jerry Dean, the mooring and instrument preparation and operations led by David Simoneau and Joe Poirier, and the data processing led by Ann Spencer. In addition Peter Clay, Matthew Gould, Clayt Collins, Brian Skelly, Scott Worrilow, Willy Ostrom, Rick Trask, and Bob Weller and Bob Reid from C. S. Draper Labs have been on many cruises or spent many hours in special efforts for the project.

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INTRODUCTION

The Long Term Upper Ocean Study (LOTUS) began in 1979 when it became clear that even massive one- to two-month upper-ocean experiments (e.g., JASIN) could not expect to yield the large variety of possible environmental conditions, nor could they provide any insights into seasonal effects or give long-term statistical response models.

After an engineering period and a collection of historical data (Trask, Briscoe, and Pennington, 1982), the first LOTUS scientific moorings were set in May 1982 at the old Woods Hole Site L (Figure 1), in an array (Figure 2) designed to sample the surface meteorology and full water column (moorings 767 and 766) as well as the larger-scale properties of the mesoscale field (moorings 764 and 765). Surface mooring 767 (designated LOTUS-3; LOTUS-1 and -2 were earlier tests) was replaced by 770 (LOTUS-4) in October 1982, and the entire array was replaced in April 1983 (LOTUS-5).

This report describes the data from the 764, 765, 766, 767, 770 mooring array, as well as some associated data. A later report will describe the second year of the experiment. The hydrographic data (XBT and CTD) are described in each cruise report (see REFERENCES) and are only summarized here.

A. Moorings

Figure 3 and Table 1 give details of the moorings and locations. The bottom in the area is essentially flat and featureless sand and silt, with a nominal depth of 5368 m (corrected). The mooring diagrams show six different kinds of subsurface instrumentation (see next section) and three different kinds of moorings.

The two intermediate moorings (764 and 765) and the near-surface mooring (766) are constructed entirely of chain and wire rope, except for a short length of braided nylon line directly under the acoustic release.

The surface moorings are chain and wire rope in the top 2000 m to guard against fishbite, and braided nylon beneath for compliance. The surface moorings are slightly longer than the water depth, but the constant presence of a current at the site prevents any slack and entanglement in the mooring line. Tension measurements just under the surface buoy usually show 2000-4500 pounds

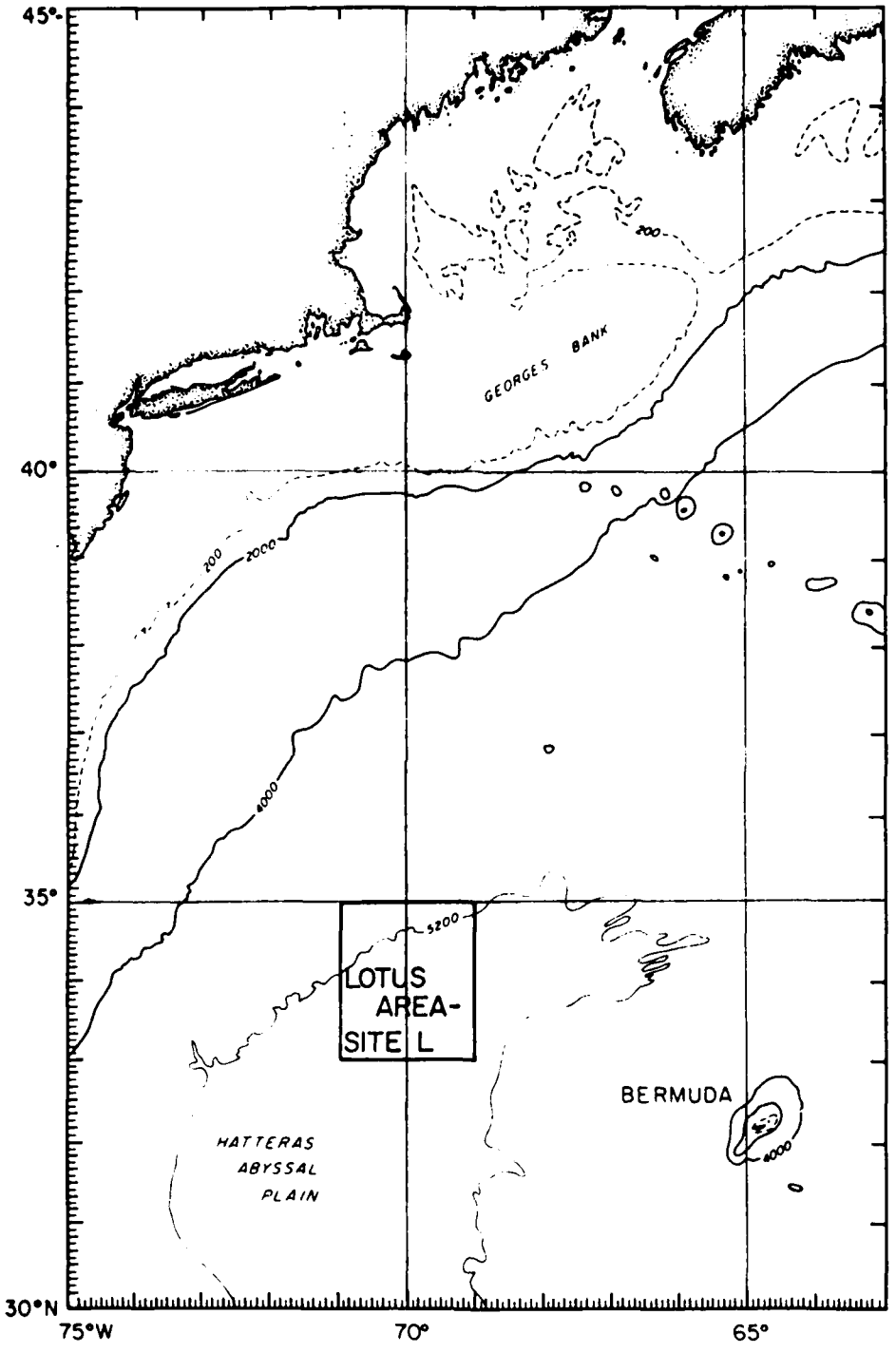

Figure 1. The location of the Long Term Upper Ocean Study area.

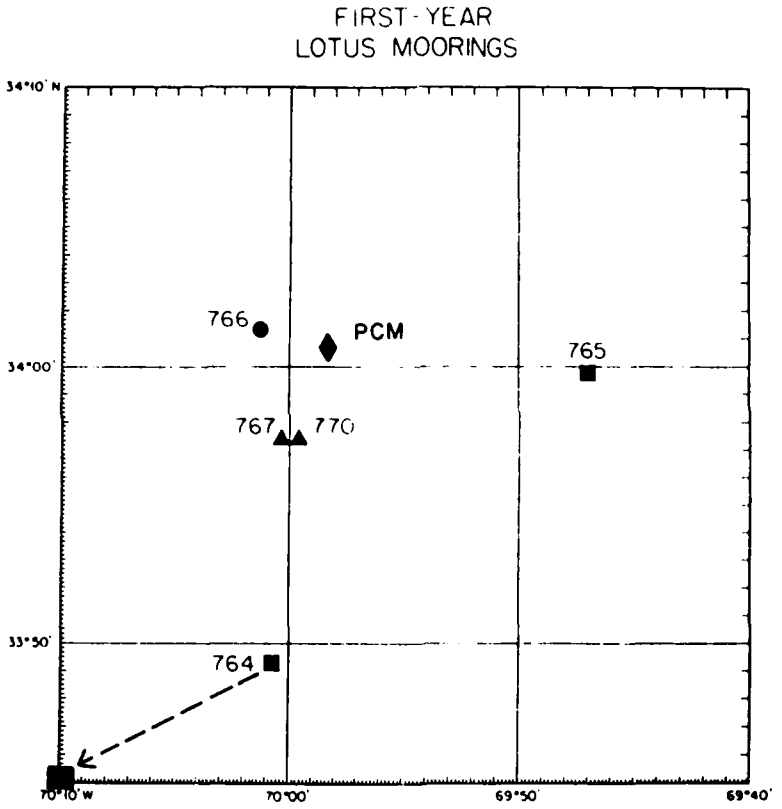

Figure 2. A chart of a section of the LOTUS area showing the location of the two LOTUS surface moorings (▲), near-surface mooring (●) and the subsurface mooring (■) during the first year of the experiment. ♦ is a MIT/CSDL moored Profiling Current Meter during May-October 1982.

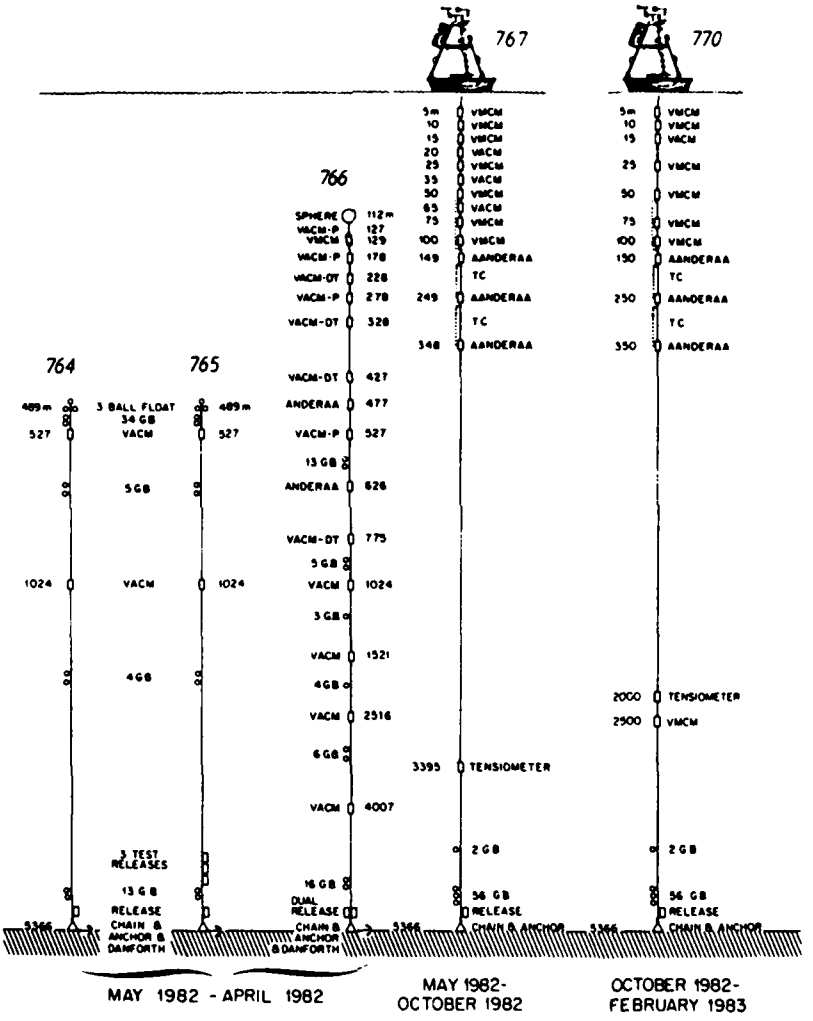

Figure 3. Mooring diagrams of the five LOTUS moorings for the first year of the experiment.

Table 1: Moori ɹ Positions

Mooring #	Days at Sea	Duration	Loran C position
764 LOTUS 3 Intermediate-South	340	8 May 1982 - 14 April 1983	33 49.16 70 00.83*
765 LOTUS 3 Intermediate-East	339	9 May 1982 - 14 April 1983	33 59.81 69 47.14
766 LOTUS 3 Near Surface	336	10 May 1982 - 12 April 1983	34 01.20 70 01.45
767 LOTUS 3 Surface	170	12 May 1983 - 30 Oct. 1982	33 57.16 70 01.31
770 LOTUS 4 Surface	110	31 Oct. 1982 - 19 Feb. 1983	33 57.19 69 59.71

* At deployment; after 1 June the estimated position (see text) was 33°44.6'N, 70°10.0'W.

tension, depending on the large-scale current field; local wind and current effects at the surface have little effect on the mean line tension. See also Walden and Clay (1983).

All moorings recovered from the site have shown evidence of fishbite (teeth marks or even removal of the PVC jacket on the wire rope), especially in the 500-1000 m depth range.

Movement of Mooring 764

Intermediate mooring 764 was set on 8 May 1982 (OCEANUS Cruise 119) at 33°49.16'N, 70°00.83'W (Northstar 7000 Loran C coordinates). When the mooring recovery was attempted on 14 April 1983 (ENDEAVOR Cruise 97), it did not surface near the deployment position but rather some 10 miles to the southwest. In fact, it was 3 hours from the time of release to the time of actually grapnelling the mooring, at which time the position was 33°44.19'N, 70°13.73'W (Loran C), or 11.9 miles WSW of the deployment site.

Study of the pressure and temperature records from mooring 764 show that a strong, nearly barotropic, southwesterly current on 30-31 May 1982 pushed the top of the mooring over some 70 meters. Early on 31 May, as the current was continuing to increase, the pressure suddenly dropped by 70 decibars on both instruments on the mooring, and the measured current dropped about 20 cm/s at the 1024 m instrument and 10 cm/s at the 527 m instrument. Over the next 33 hours the two pressure records stayed about constant except for three or four short (1-2 hour) 5-20 decibar (increasing) pressure spikes. On the afternoon of 1 June the pressure suddenly increased by 30-35 decibars and settled out to a new equilibrium; at the same time the measured current increased by 8-10 cm/s to a new value a little less than the value on 31 May prior to the pressure decrease.

Our conclusions are:

(1) The horizontal holding power of the clump (dead weight) anchor was insufficient to keep the anchor from dragging under the high-current condition on 31 May. Possibly the Danforth anchor attached to the clump did not deploy correctly.

(2) The mooring began to move at a maximum of 20 cm/s in a direction between 230°-250° T, and fetched up 33 hours later while moving at some 8-10 cm/s.

We estimate the 20 cm/s speed (or higher) occurred for about 13 hours, followed by a 7 hour decrease to (say) 9 cm/s, and then constant for 13 hours; this gives an approximate average speed of 14.5 cm/s, and a total distance travelled of 17.2 km or 9.2 n.mi. in a direction approximately 240° T.

(3) The drift of the ship was 0.7-2.1 knots in directions from 201° T through west and north to 072° T, during the period from 10 minutes before the release of 764 to 55 minutes afterwards, as we were hove to listening to the radio and acoustics and watching for a light. The average speed and speed-weighted average direction was 1.4 knots toward 291° T. The wind during the time was light and out of the North, so we can assume the mooring drifted at a speed of O(1) knot in a westerly to southerly direction, for a period of about 3 hours for a distance of about 3 n.mi.

(4) Using a trial and error search algorithm, we looked for an inferred anchor position that (a) was close to being 240 T from the original anchor position, and approximately 9.2 n.mi. from it, and (b) was in the NW quadrant from the recovery position and about 3 n.mi. from it. There is no unique solution to this search, but the points cluster around 33°44.6'N, 70°10.0'W (Loran C) with a scatter of about a mile N-S and half a mile E-W.

(5) Summary: Mooring 764 moved SW about 9 n.mi. on 31 May-1 June 1982. The final position was 33°44.6'N, 70°10.0'W, within 1/2 to 1 mile. The position is consistent with current measurements and recovery data.

B. Instrumentation

1. Current Meters

The primary current meters used in the LOTUS experiment are Vector Averaging Current Meters (VACM) and Vector Measuring Current Meters (VMCM). They differ mainly in their flow-sensing elements: the VACM uses a Savonius rotor and a vane to give speed and direction which are resolved against an internal compass to East and North components whereas the VMCM uses orthogonal cosine-response propellers that sense directly the flow components which are then rotated relative to an internal compass.

Both instruments provide a continuous vector-averaging during a recording interval by sampling 8 (VACM) or 4 (VMCM) times per rotation of the sensor;

both cases correspond to sampling and vector-averaging at least several times per second.

The last of the statistics tables (p. 154) gives the instrument identification numbers for each depth and mooring.

The recording interval of the instruments depends on the planned deployment period of the mooring to which they are attached. The one year moorings have current meters with recording intervals of 7.5 minutes whereas those on the 6 month moorings have a 3.75 minute recording interval.

Additional technical information on the VACM and its sensors may be found in Fofonoff and Ercan (1967), McCullough (1975), Payne et al. (1976), and Dean (1979). The VMCM is described in Weller and Davis (1979). Intercomparisons of these instruments are given in Halpern et al. (1981).

Both current meters record on Phillips-type cassettes by means of Sea Data recorders. The cassettes are removed ashore and transcribed to 9-track computer tapes for further processing.

Temperature measurements are made by both the VACMs and VMCMs. The VACM temperature sensor (a thermistor embedded in its end cap just above the vane) has an accuracy and resolution of approximately .01°C (Payne et al., 1976), and $.07 \times 10^{-3}$°C (Tarbell et al., 1979) respectively. Some VACMs have either a pressure sensor (VACM-P) (located just above the vane) or a pair of thermistors separated by approximately one meter to give the vertical temperature gradient (VACM-DT) (Dean, 1979). The time response of the end-cap thermistor is approximately 94 s, whereas the thermistor system used in the VACM-DT has a 12 s response (Levine, 1981); this difference can affect certain kinds of data comparisons.

Only the temperature and pressure sensors are calibrated prior to deployment; the rotor and vane weights, sizes and bearing clearances are simply kept within narrow specifications to permit the nominal calibrations (McCullough, 1975) to be used.

The VMCM also senses temperature with a thermistor embedded in the upper end cap of the pressure case. According to the manufacturers specifications a calibrated thermistor has an accuracy of .01°C. For the temperature range selected for the LOTUS VMCMs (17°C to 30°C) the resolution of the system is 1.4×10^{-3}°C.

2. VMCM Variations

The VMCM is a relatively new instrument undergoing continuous tests to perfect its long term performance. One component of the instrument which is under examination is the material used for the orthogonal propellers. Propellors fabricated of black Delrin (a Dupont Co. Acetal homopolymer resin) were used on the LOTUS 3 and 4 VMCMs. The color black was chosen to decrease their visibility and thus discourage any interference by fish.

Various antifouling compounds were tested on the LOTUS 3 VMCM propellers. The propellers of several instruments were coated with antifouling paint, wax, and in one case a combination of paint and wax while the propellers of one instruments were left bare. The LOTUS 4 VMCM propellers contained no antifouling compounds.

The LOTUS 4 propeller assemblies differed from those used in LOTUS 3 in that the blades were fitted to the hub with a dovetail joint and pinned. Each propeller was also balanced. The LOTUS 3 propeller had rabbet joints with pins and was not balanced.

Another aspect of the VMCM under careful study is the type of bearings used on the propeller shaft. The LOTUS 3 VMCMs used type 316 stainless steel bearings as did the LOTUS 4 VMCMs, however, the LOTUS 4 instruments had an additional 18-8 stainless steel retainer ring attached around the shaft which limited any excessive lateral movement.

Table 2 summarizes the variations between the LOTUS 3 and 4 VMCMs.

TABLE 2: VMCM Variations

	Propeller Material	Antifouling Compounds		Bearings
		Paint	Wax	
LOTUS 3	Black Delrin Blades rabbet jointed at hub; not balanced	5m, 10, 25, 75	5m, 50, 100	Type 316 Stainless
LOTUS 4	Black Delrin Blades dovetail jointed at hub; balanced	None		Type 316 Stainless with 18-8 retainer ring

3. Aanderaa Temperature Recorders

Each LOTUS surface mooring (LOTUS 3 and LOTUS 4) had three 100 m long Aanderaa thermistor cables with recorders. The recording packages were each held in stainless steel brackets with strength members that were fastened in line with the mooring. The thermistor cables were attached to the mooring line with clamps manufactured by the Stauff Corporation. Nominally the thermistor cables were situated between 50 and 350 meters depth passing by several current meters where necessary. The thermistor cables contain 11 thermistors each separated by 10 meters.

The temperature range of the thermistor chains used during LOTUS is 10.08° to 36.04°C. The resolution of the temperature measurements is .025°C. The 6 month deployment period and the limited tape capacity restricted the sampling interval to 60 minutes.

Calibration of the thermistor cables was performed at WHOI. The procedure involved immersing the entire cable into a calibration bath and then decreasing the bath temperature in a series of steps from 30° to 10°C. Calibration coefficients are calculated for each thermistor using a second order polynomial.

Two other Aanderaa recorders, modified at WHOI to make single temperature measurements, were placed on the LOTUS near-surface mooring (mooring 766) at 477 and 626 meters. These recording units did not have a multi-sensor cable but rather a single thermistor fastened to the instrument's top end cap. The deployment period for these instruments was one year, which when combined with the reduced data input, allowed a sampling interval of 20 minutes. Aside from the differences mentioned above, the specification of the single point instruments are identical to those used with thermistor cables.

4. Vector-Averaging Wind Recorder

The Vector-Averaging Wind Recorder (VAWR), an adaption of the Vector Averaging Current Meter (VACM), was designed at WHOI for making high quality, long duration observations of meteorological parameters from moored oceanic buoys. The VAWR contains integrating and recording circuitry which computes vector-averaged wind velocity. The VAWR also provides several channels for recording additional measurements. The VAWRs used in LOTUS were fitted with

more responsive wind sensors and were designed to cause much less flow disturbance around the wind sensors than the VAWR used previously. Two VAWRs were mounted on the tower of LOTUS-3. On LOTUS-4, the VAWR electronics packages were placed inside the instrument well primarily to increase the mechanical stability of the buoy, to prevent theft by vandals of the self-recorded data, and to more fully expose the navigation light on the tower. The VAWRs on LOTUS-3, serial No. 184 and No. 537, recorded data averaged over 3.75 min., those on LOTUS-4 serial No. 177 and No. 381, recorded data averaged over 7.5 min. The averaging interval was thus doubled to accommodate the extra relative humidity data being recorded on LOTUS-4. These sampling rates were long enough to average out the bulk of the buoy motion effects but still short enough to retain high-frequency variability in the meteorological data. Table 3 is a summary of the meteorological sensors and their specifications. See Deser et al. (1983), for additional meteorological information.

C. Other Data

1. XBT and CTD

During each cruise to the site, an XBT section was made along approximately 70°W from about 40°N to 34°N, and CTD stations were made near the moorings and around the array. These data are all given in detail in each cruise report: OCEANUS 119 and 129, and ENDEAVOR 97 are relevant to the mooring data described here. All the CTD stations that were taken during the first year in the LOTUS area are shown by position in Figure 4. For general reference, Figures 5a and 5b show typical CTD profiles at the LOTUS site for each season. Below 200 m there is little seasonal influence, but the mesoscale effect of a variable eddy field is visible especially in the main thermocline.

2. Aanderaa Temperature Recorders

A complete report on the data quality and results from the Aanderaa equipment will be given elsewhere. The purpose of it on the surface moorings was to give 10 m resolution between 50 and 350 m for the measurement of the depth of the mixed layer. The severe wave-driven motions of the surface mooring, however, caused difficulties with the simple reel-to-reel Aanderaa tape recorders and the 100 m long thermistor strings. The data progressively degraded during the deployment period, so only at the beginning of each 6-month deployment do we have the desired resolution.

Table 3: Meteorological sensors and their specifications

TABLE 2: METEOROLOGICAL SENSORS

	Parameter	Sensor	Manufacturer	Range	Sensor Accuracy	System Accuracy	LOTUS-3	LOTUS-4	Comments
TELEMETERED	1. Wind speed	Gill 3-cup anemometer	R.M. Young Co., model 6301	0-54 m/s	See Text	0.2 m/s(c)	X	X	
	2. Wind direction	Vane	R.M. Young Co., model 6101	0-360°	See Text	5°(s)	X	X	
	3. Air temperature	Thermistor with Thaller Shield	Yellow Springs Instrument Co., model 44034	±35°C	0.1°C	0.5°C(s)	X	X	
	4. Hull temperature	Thermistor	Yellow Springs Instrument Co., Model 44034	±30°C	0.1°C	0.3°C(s)	X	X	
	5. Barometric pressure	Digiquartz with Gill Pressure port	Paroscientific,Inc. Model 215	0-1034 mb	0.2 mb	0.5 mb(m)	X		
		Aneroid	Yellow Springs Instrument Co., model 2014-28/35 RA-3-MB	984-1064 mb	3 mb	5 mb(c)		X	
	6. Tension (at top of mooring)	Hydraulic piston	W. Swift Co., Bourne, MA	0-9300 lbs.		40 lbs(c)	X	X	
VAMR 1	1. Wind speed	Gill 3-cup anemometer	R.M. Young Co., model 6301	0-54 m/s	See Text	0.1 m/s(c)	X	X	LOTUS-3, #184, Sampling rate: 3.75 min
	2. Wind direction	Vane	R.M. Young Co., model 6101	0-360°	See Text	5°(s)	X	X	LOTUS-4, #177, Sampling rate: 7.5 min.
	3. Air temperature	Thermistor with Thaller Shield	Yellow Springs Instrument Co., model 44034	±35°C	0.1°C	0.3°C(m)	X	X	
	4. Sea temperature	Thermistor	Thermometrics Co.	±30°C	0.004°C	0.01°C(e)	X	X	
	5. Solar radiation	Pyranometer	Eppley Co., model 8-48	0-1400W/m^2	3%	5%(m)		X	
			HYCAL Eng., model P-4405-A	0-1400W/m^2	3%	5%(m)	X		
	6. Relative humidity	Strain gauge	HYCAL Eng., model HS-3552-8	0-100%	6%	(*)		X	(*) failed after one month
VAMR 2	1. Wind speed and direction	Integral 3-cup anemometer and vane	WHOI	0-54 m/s 0-360°	See Text	0.1 m/s(s)	X		LOTUS-3, #537, Sampling rate: 3.75 min
	2. Wind Speed and direction	Propeller and vane	R.M. Young Co., model 5101	0 50 m/s 0-360°	See Text	5°(s)		X	LOTUS-4, #381, Sampling rate: 7.5 min.
	3. Air temperature	Thermistor with PML shield	Yellow Springs Instrument Co., model 44034 housing - Polar Research Labs.	±35°C	0.1°C	2°C(s)	X		
	4. Barometric pressure	Digiquartz with Gill Pressure port	Paroscientific, Model 215-A5-002	0-1034 mb	0.1 mb	0.5 mb(m)	X	X	
	5. VAMR electronic chassis temperature	Thermistor	Yellow Springs Instrument Co., Model 44034	±35°C	0.1°C	0.1°C(e)		X	Engineering test sensor

(c) ARGOS digitization resolution
(s) Scatterplot estimate
(m) Manufacturer's value
(e) Estimate based on previous experience

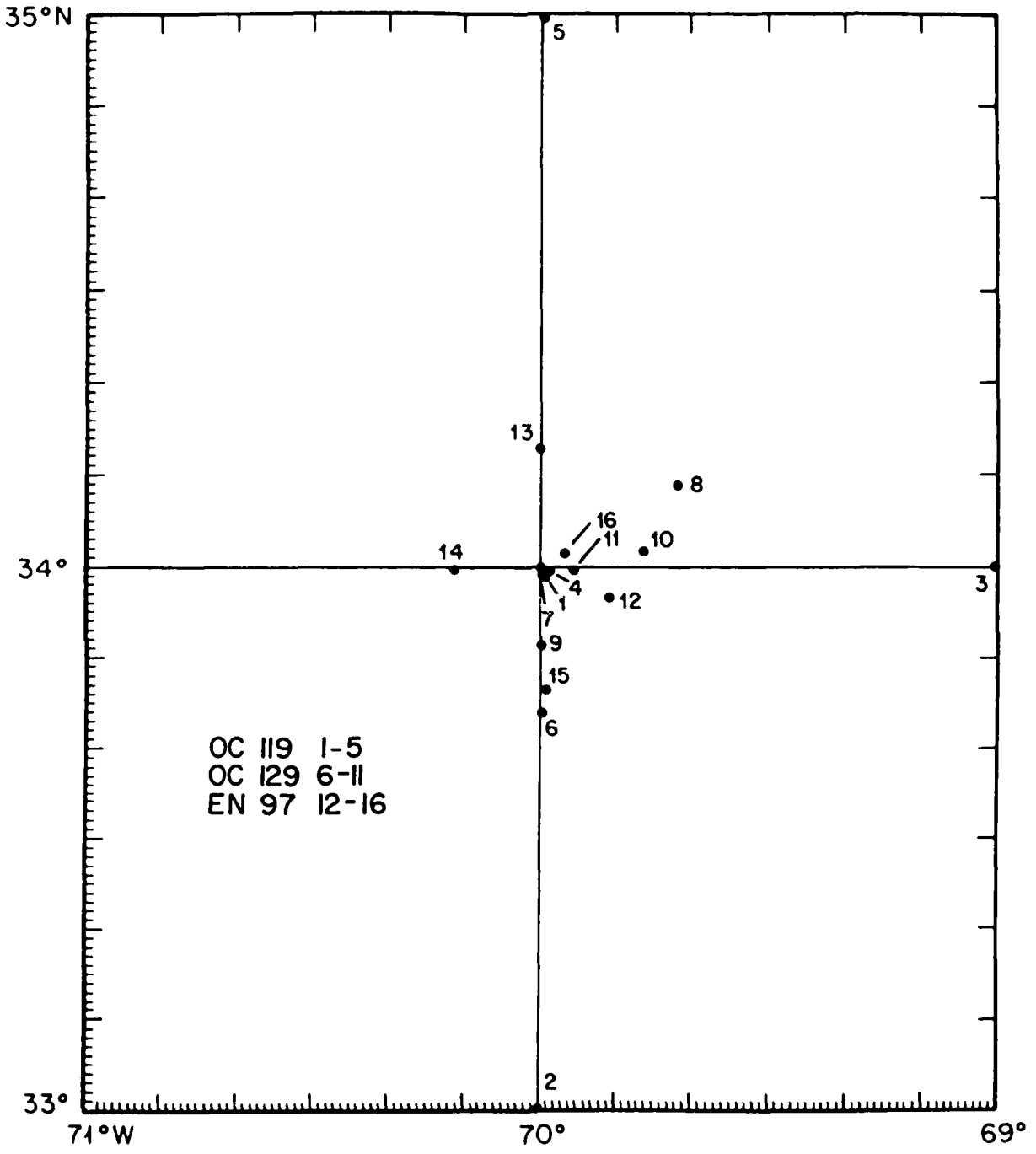

Figure 4. Locations of CTD stations in the LOTUS area taken during the first year of LOTUS.

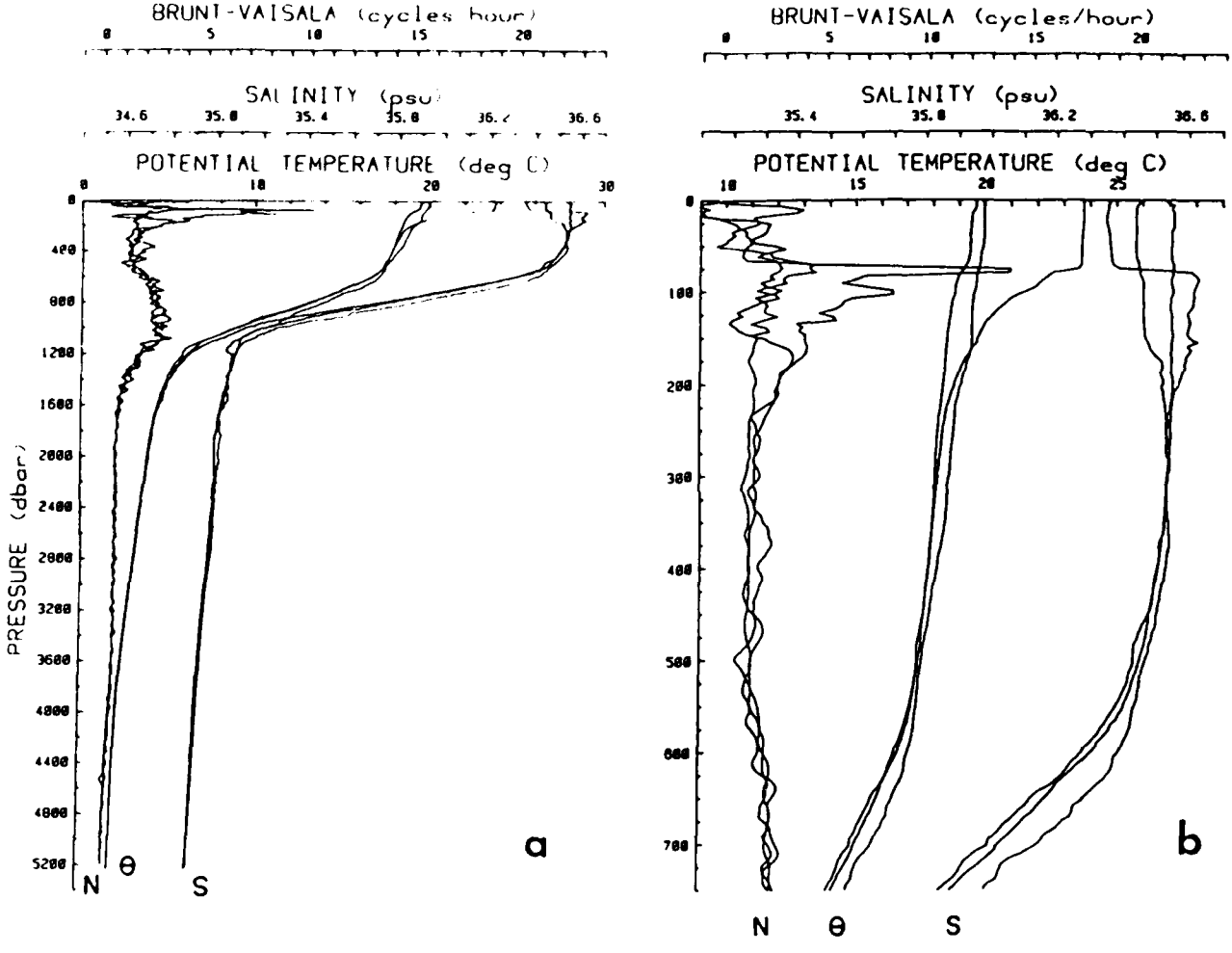

Figure 5. a) Total depth CTD profiles for the LOTUS area for each of the first three cruises.
b) Blowup of upper 750 m.

3. Profiling Current Meter (PCM)

The M.I.T.-Draper Profiling Current Meter (PCM) is a programmable moored upper ocean current and density profiler capable of making over 1000 repeated profiles from 20-200 m depth along the upper section of a barely subsurface mooring. It is free to move along the guideline portion of its mooring by adjusting its buoyancy under computer control of an electric oil pump/swim bladder assembly. As the instrument ascends, it measures current with a spherical 2-axis electromagnetic current probe, temperature with a thermistor, electrical conductivity with an inductive cell, and pressure with a strain gauge. Samples are accumulated at 1 Hz and averaged into pre-programmed depth bins, typically 5 m thick. Magnetic field and tilt information are used to vector-average horizontal current data. The instrument maintains a rise rate of 10-15 cm/s during ascents so that profiles can be repeated as often as 1 hour. Battery and tape recorder storage provide the principal limitations to the duration of the PCM deployments. The instrument relies on computer software to manage finite resources efficiently. PCM1F was moored at 33°59.6'N, 69°56.8'W, during May-October 1982. The instrument is not from Woods Hole and the data are not presented here.

4. Engineering Data

The VACM pressure sensors on the subsurface moorings are useful engineering data: during low current periods they confirm the nominally calculated depths of instruments, and during high current periods they help relate the currents to mooring tilt-over. In fact, an error in the counter used to measure the wire rope for 764, 765, 766, and 767 was detected and the instrument depths corrected by use of the pressure records.

The tensiometer on each surface mooring gives a simple strip-chart (Rustrak) recording of a load-cell output. On LOTUS-3 at 3395 m the tensiometer was in the nylon part of the mooring and saw only the low-frequency tension changes as the mooring responded to the depth-integrated current. On LOTUS-4 at 2000 m the tensiometer was at the bottom of the chain/wire-rope part of the mooring, and essentially all of the high-frequency tension fluctuations caused by the surface waves were measured there. The conclusion is that the high frequency fluctuations are damped out in the top section of nylon; this is apparently why the top nylon pieces of the LOTUS-1 and -2 test deployments were so weakened when examined after recovery.

D. Data Quality

Figure 6 shows all the data considered good that were returned from the first year of LOTUS. Bar graphs are for current meter data, meteorological data and Aanderaa thermistor chain data.

E. Data Processing

Time series are identified by a three digit mooring number, a sequential instrument position number, a letter to indicate the data version, and a number to indicate the time sampling interval of that data set. Sequential position numbers if preceded by an "S" indicate that the instrument was set on the surface buoy. 770S1E1DG24 is the first instrument set on the surface flotation of mooring 770. It has been edited to the Eth version and has a sampling of one point per day from a Gaussian filter which has a half width of 24 hours. Similarly, 7642C450 is the second instrument on mooring 764. It has been processed to the Cth version which is sampled every 450 seconds (or 7 1/2 minutes).

Data from cassettes were transcribed onto 9-track magnetic tapes, converted to scientific units, edited to remove launch and retrieval transients and erroneous data values. All the directional values have been converted from the Magnetic North co-ordinate system to True North.

Low passed versions of the data series were formed by passing the data through a Gaussian filter with a 24 hour half-width, then subsampling the resultant series once a day. The unfiltered series all start at noon, therefore the filtered series also present noon data points.

F. Data Presentation

Following the text, composite plots are presented. They show the first year's data. Aanderaa thermistor chain data, current meter temperatures, current meter speeds, progressive vector diagrams of the current meter data are shown respectively.

The data are broken up into three groups. The meteorological data are presented first. Time series, histograms and spectra for the VAWRs (Vector Averaging Wind Recorder) are shown. The second group of data is the current meter data for the two six month surface moorings. The third group is the

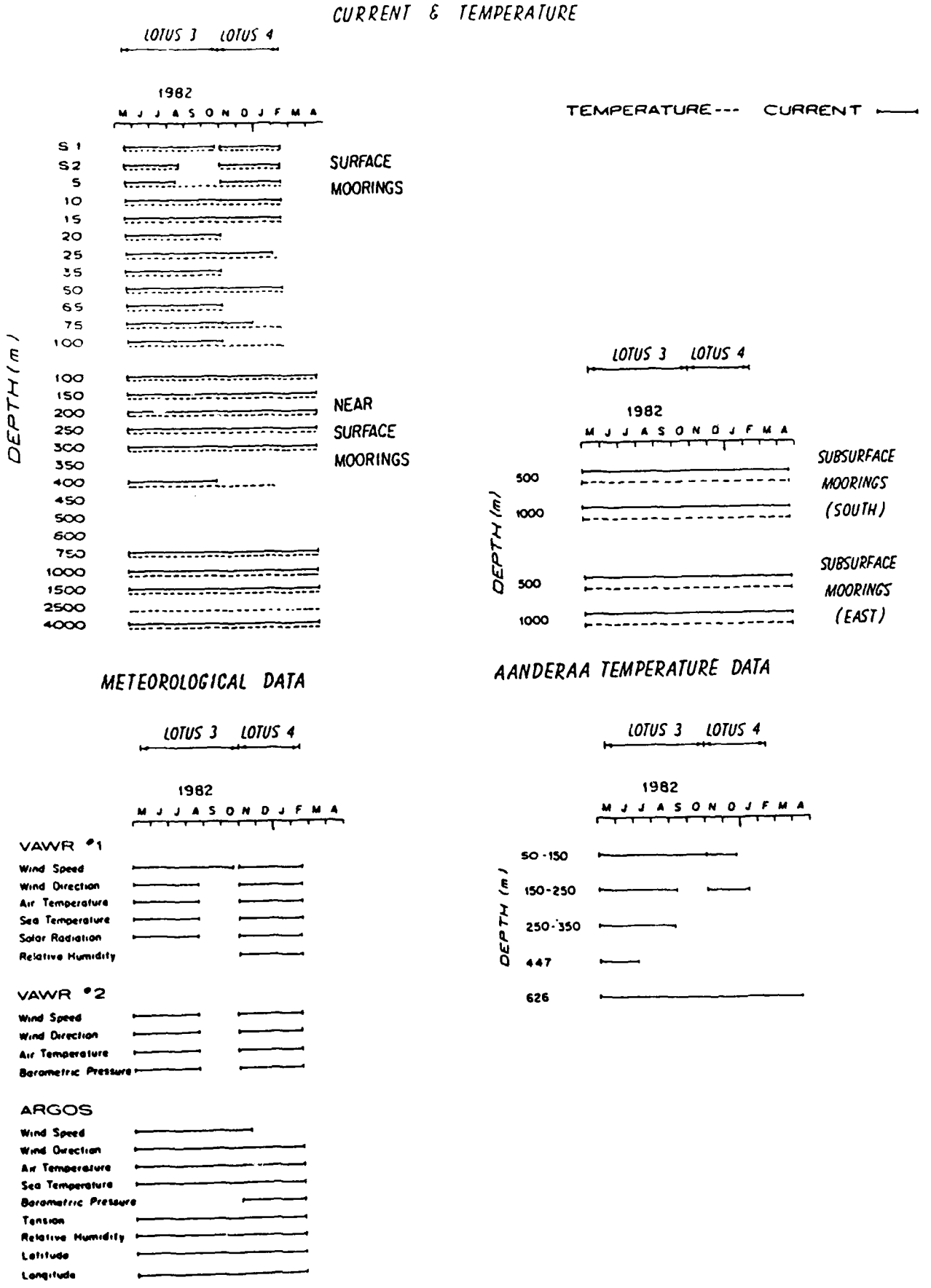

Figure 6. Bar chart showing data return for the first year of LOTUS.

near surface moorings and two subsurface moorings which are presented by depth. All the time series are first followed by the histograms then the spectra in each group. The statistics for all the instruments are presented at the end of the data section.

The following is a brief description of the different plots.

Progressive Vector Diagrams

Current vectors from the filtered time series are placed tail-to-head so as to show the path that a particle in a perfectly homogeneous flow would have traveled. The plots for each time series begin with an asterisk and are annotated monthly. Moorings 767 and 770 were set consecutively, so the progressive vector diagrams representing data from instrumented mooring 770 have been appended to the plots for the same depth from mooring 767. In those cases where there is a time separation of greater than a few days the positioning of the following Provec is arbitrary.

Variables vs. Time Plots

Individual variables and the stick plots are plotted against time from one day Gaussian filtered time series.

The plots have been done to the same scales to facilitate comparisons. In the case of the deepest temperature measurements, the temperature has been plotted on two scales, first the general scale then at a scale selected for that data set that shows details. Pressures have been plotted against a negative decibar scale to invert the trace to facilitate comparisons with temperature and speed.

The plots for time series from consecutive moorings 767 and 770 are combined for appropriate depths.

Histograms

Data are taken from the unfiltered time series. For each class interval the frequency value is a percentage of the total count. For the 'weighted direction' histogram each value is weighted by the corresponding speed value before assigning to a class interval. All histograms have 50 class intervals per inch.

The plots have been done to the same scales to facilitate comparisons. In the case of the deepest temperature measurements, the temperature has been

plotted on two scales, the general scale as indicated below, then at a scale selected for the individual data set that shows details.

*** note: the histogram for 7675 which was fouled by a garbage bag.

*** note: insolation plotted at two scales to show detail by eliminating the nighttime points.

Spectral Plots

Table 4 in the Spectra section of this report shows the exact number of cycles per piece and number of pieces. Generally speaking the 225 second sampled current meters have a piece length of 32000 points. LOTUS 3 was long enough to have 2 pieces. LOTUS 4 data has only one piece. The year long nearsurface and subsurface current meters have four 16000 point pieces.

Statistics

The statistics are created from the unfiltered time series. See Volume XVII (POLYMODE Array II) of this series (see page 5) for a description of the various types of statistical parameters.

The coding on the statistics tables stand for the following instruments:

m - VMCM

v - VACM

a - VACM with Pressure

D - VACM with DT

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DATA PRESENTATION

COMPOSITES

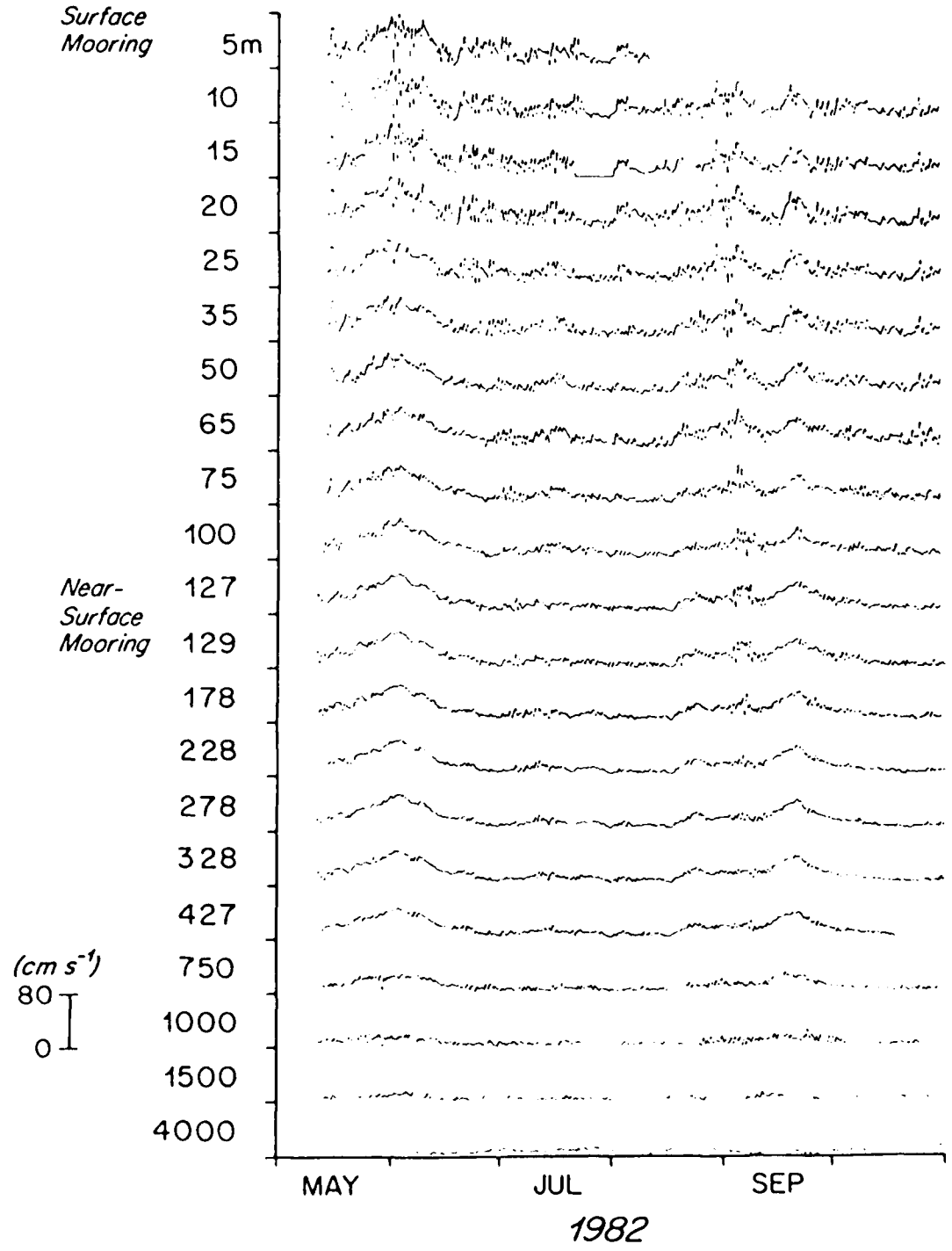


Figure 7a. Composite plot of current meter speeds for LOTUS-3.

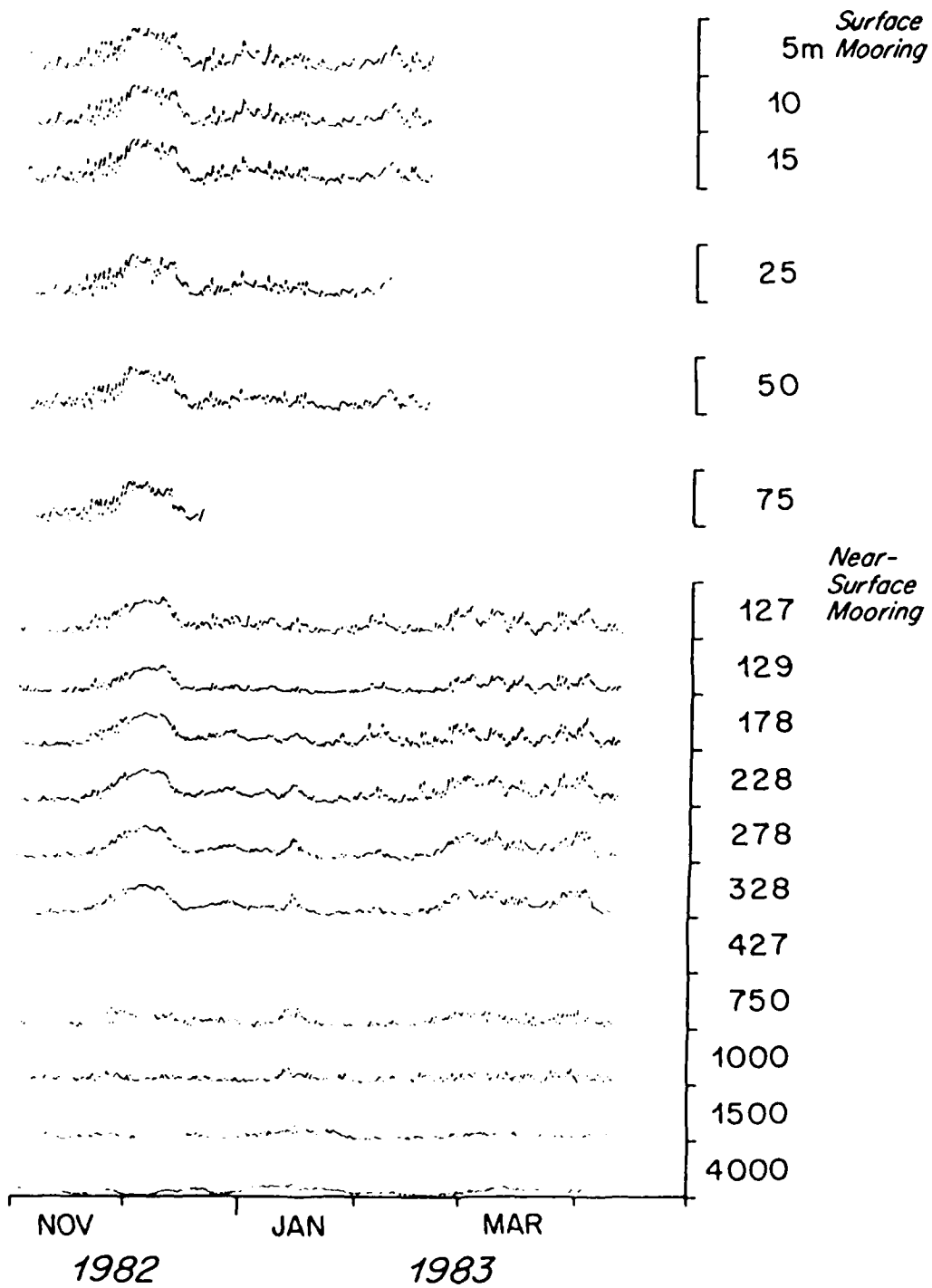


Figure 7b. Composite plot of current meter speeds for LOTUS-4.

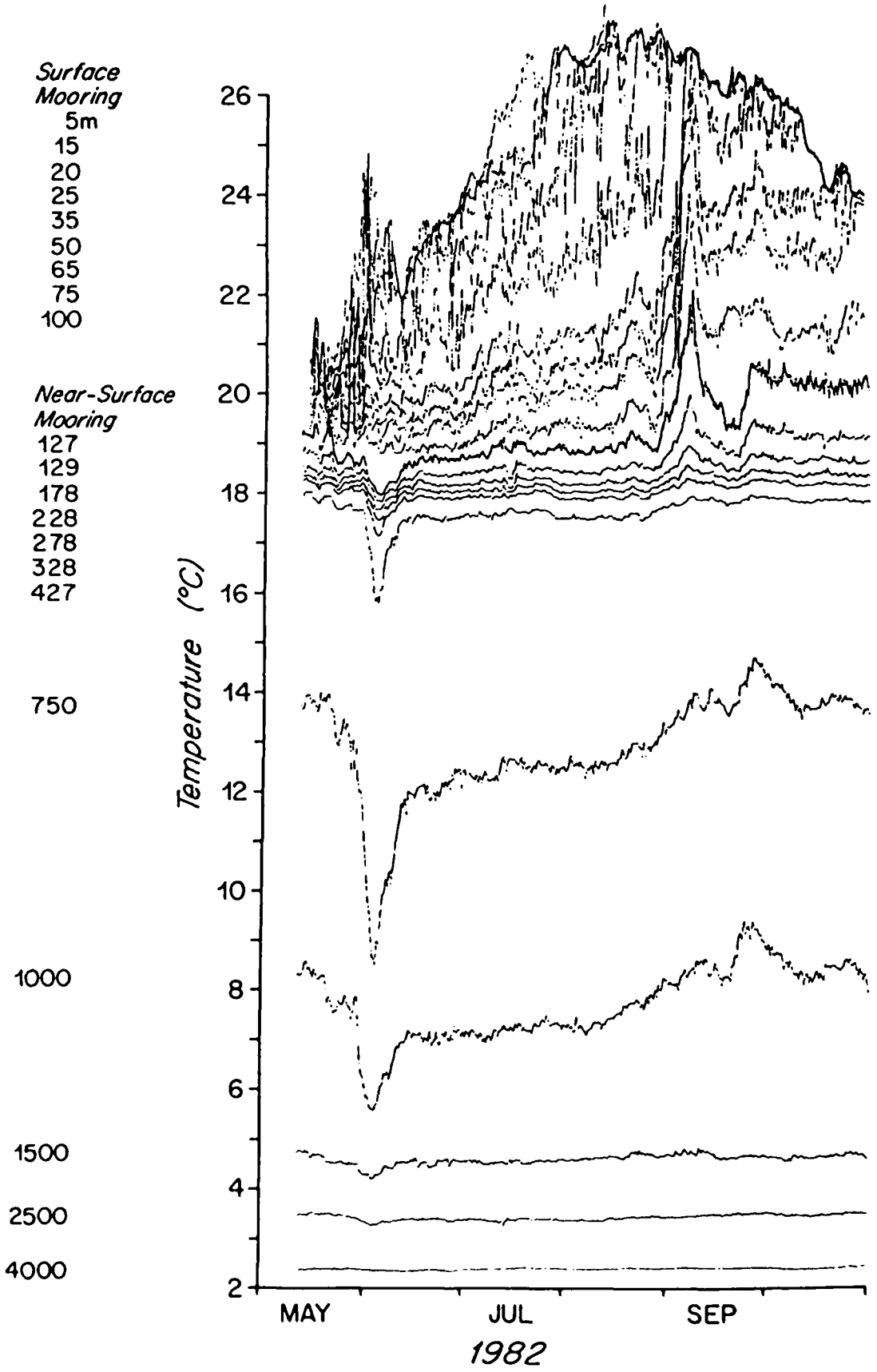


Figure 8a. Composite plot of current meter temperatures for LOTUS-3.

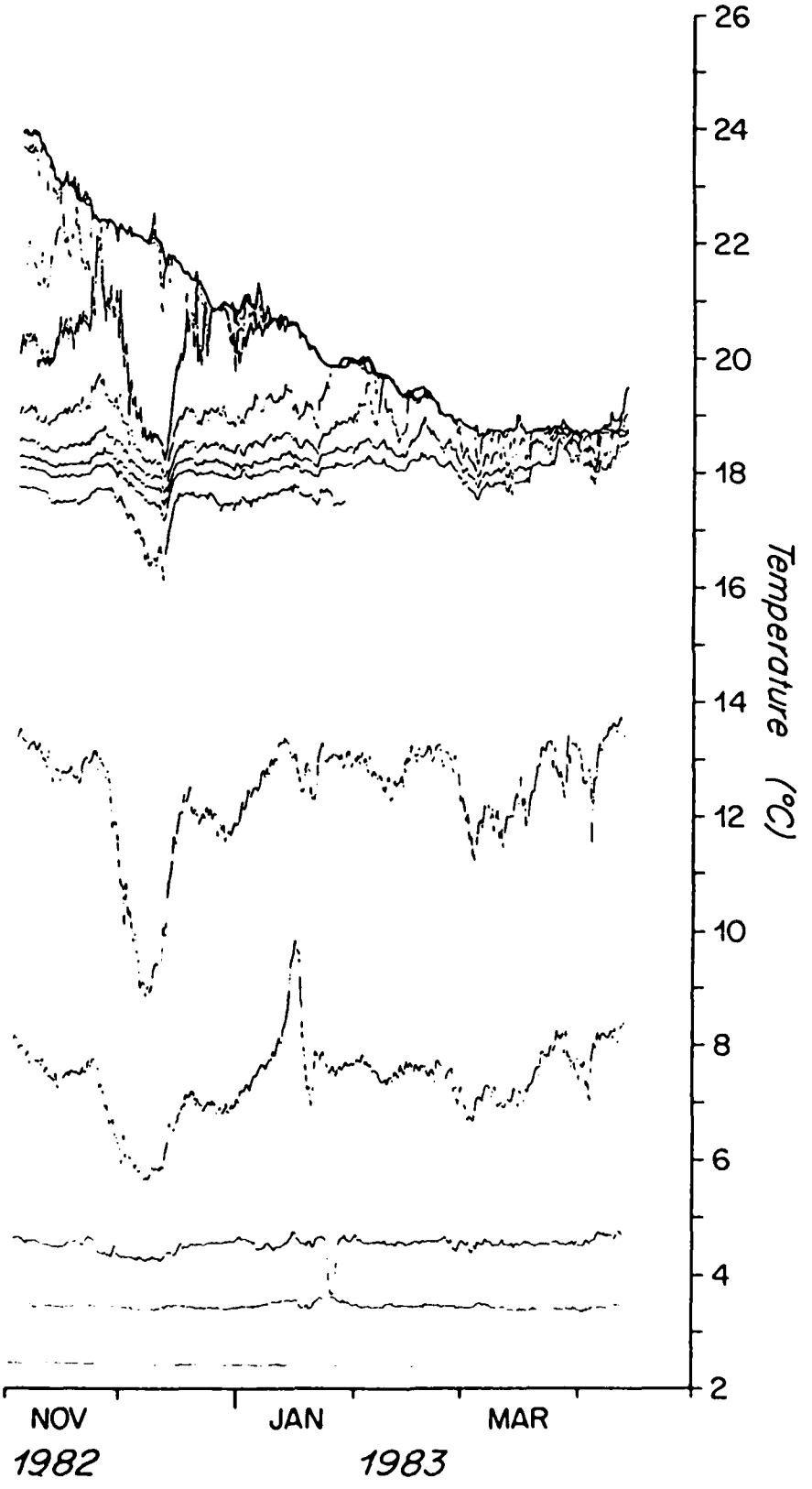


Figure 8b. Composite plot for current meter temperatures for LOTUS-4.

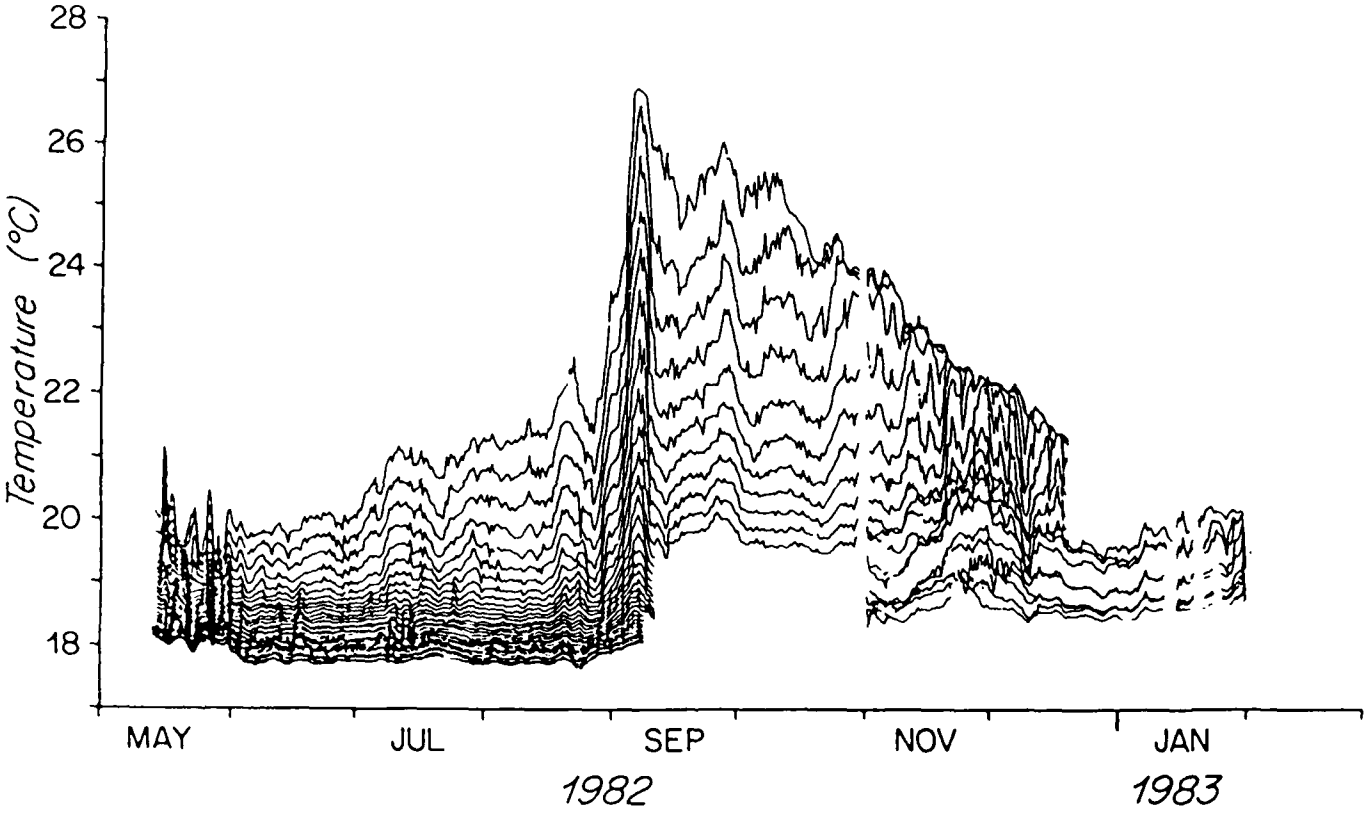


Figure 9. Composite plot of Aanderaa data from moorings 767 and 770 over the depth range of 50 to 350 m.

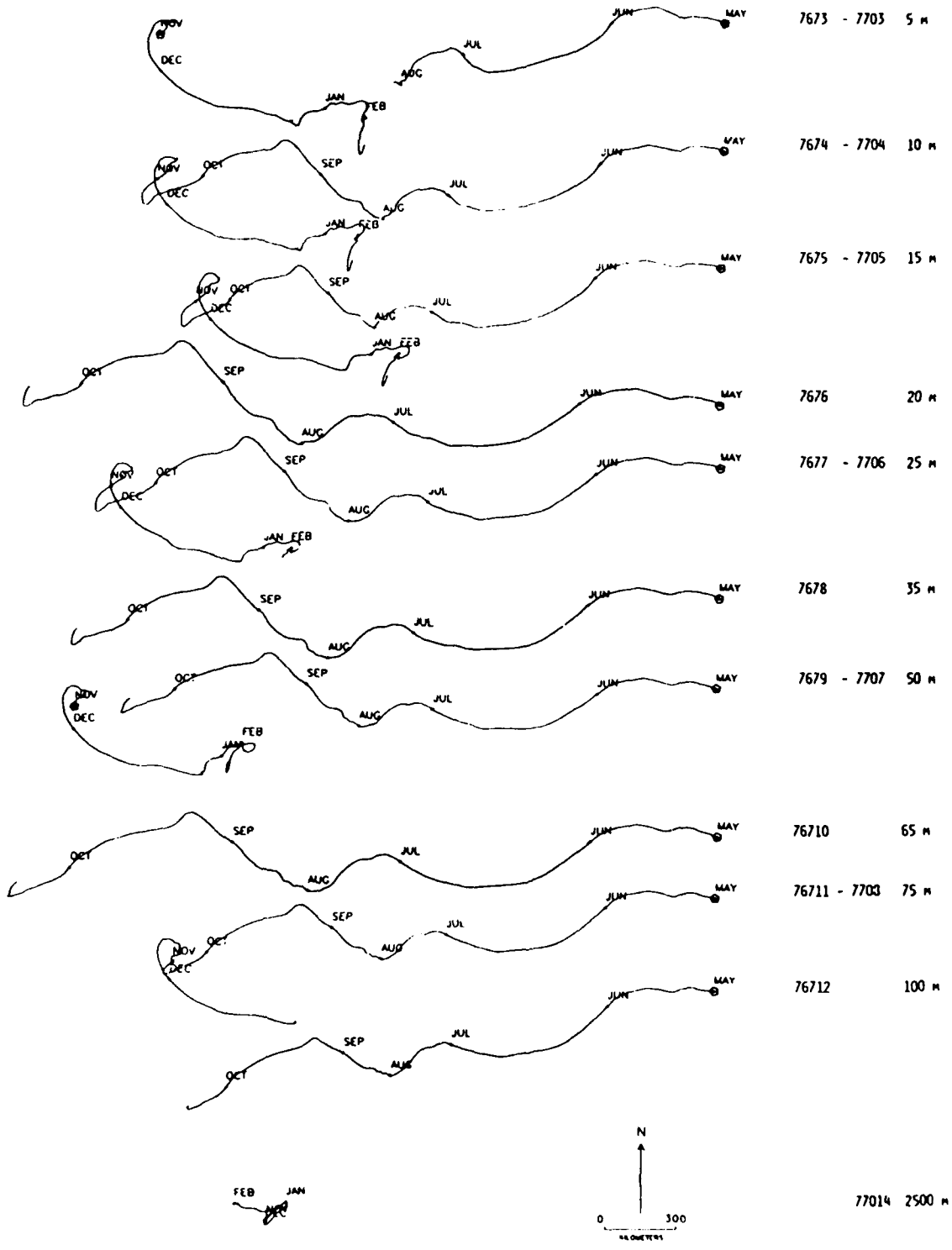


Figure 10. Composite provecs for the surface moorings 767 and 770 for the first year of LOTUS.

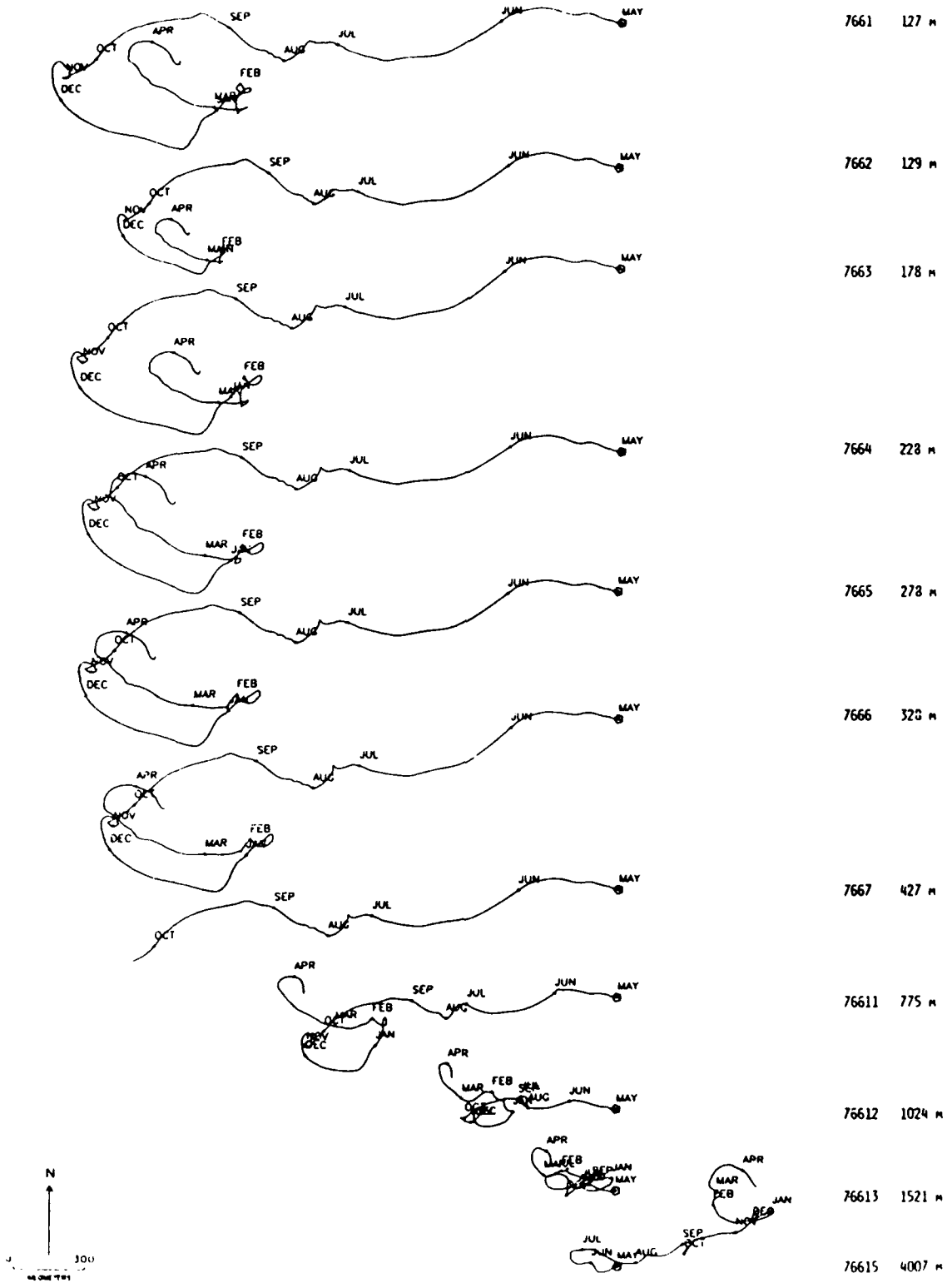


Figure 11. Composite provecs for the year long near-surface mooring 766.

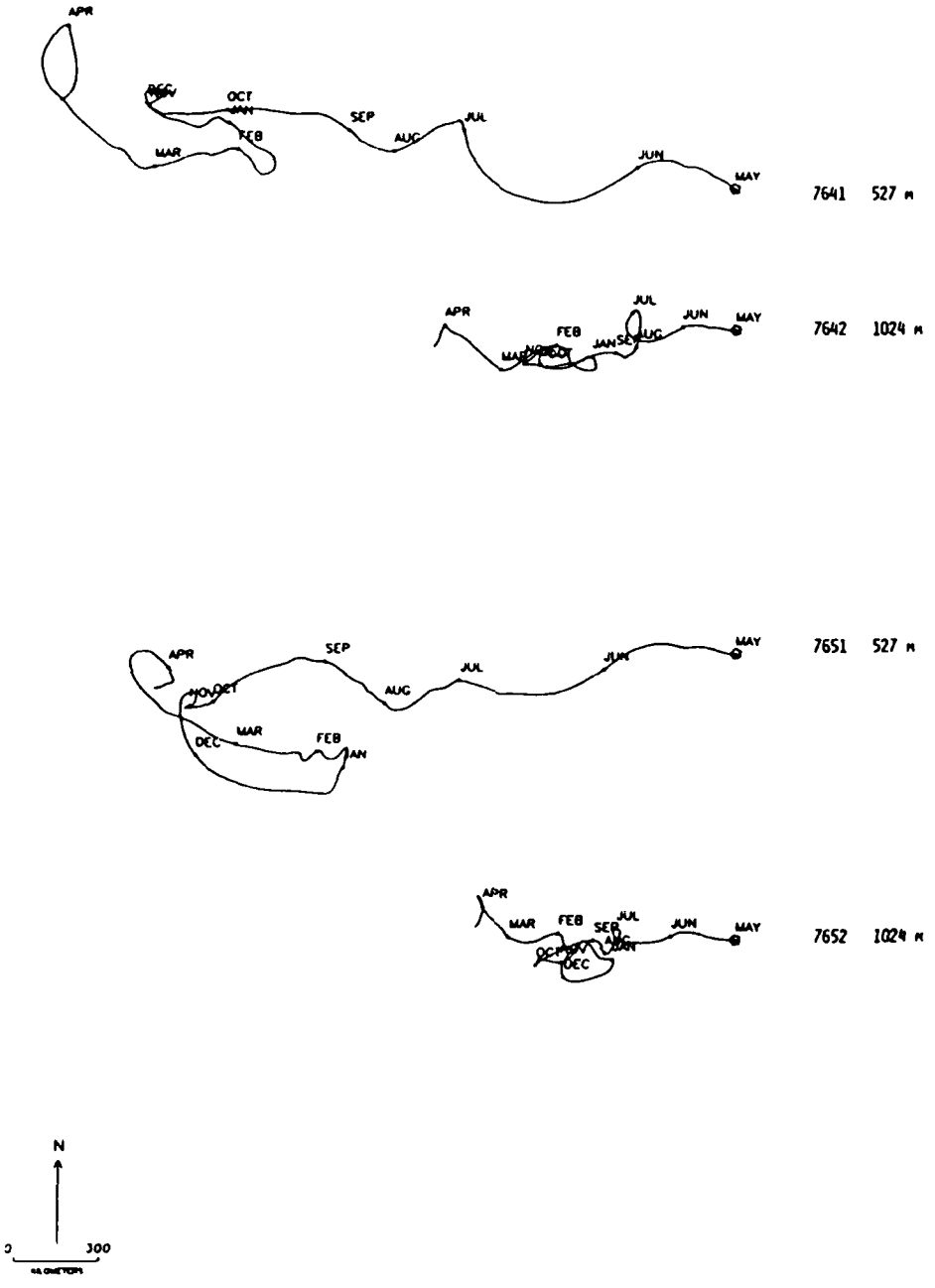


Figure 12. Composite provecs for the year long subsurface moorings 764 and 765.

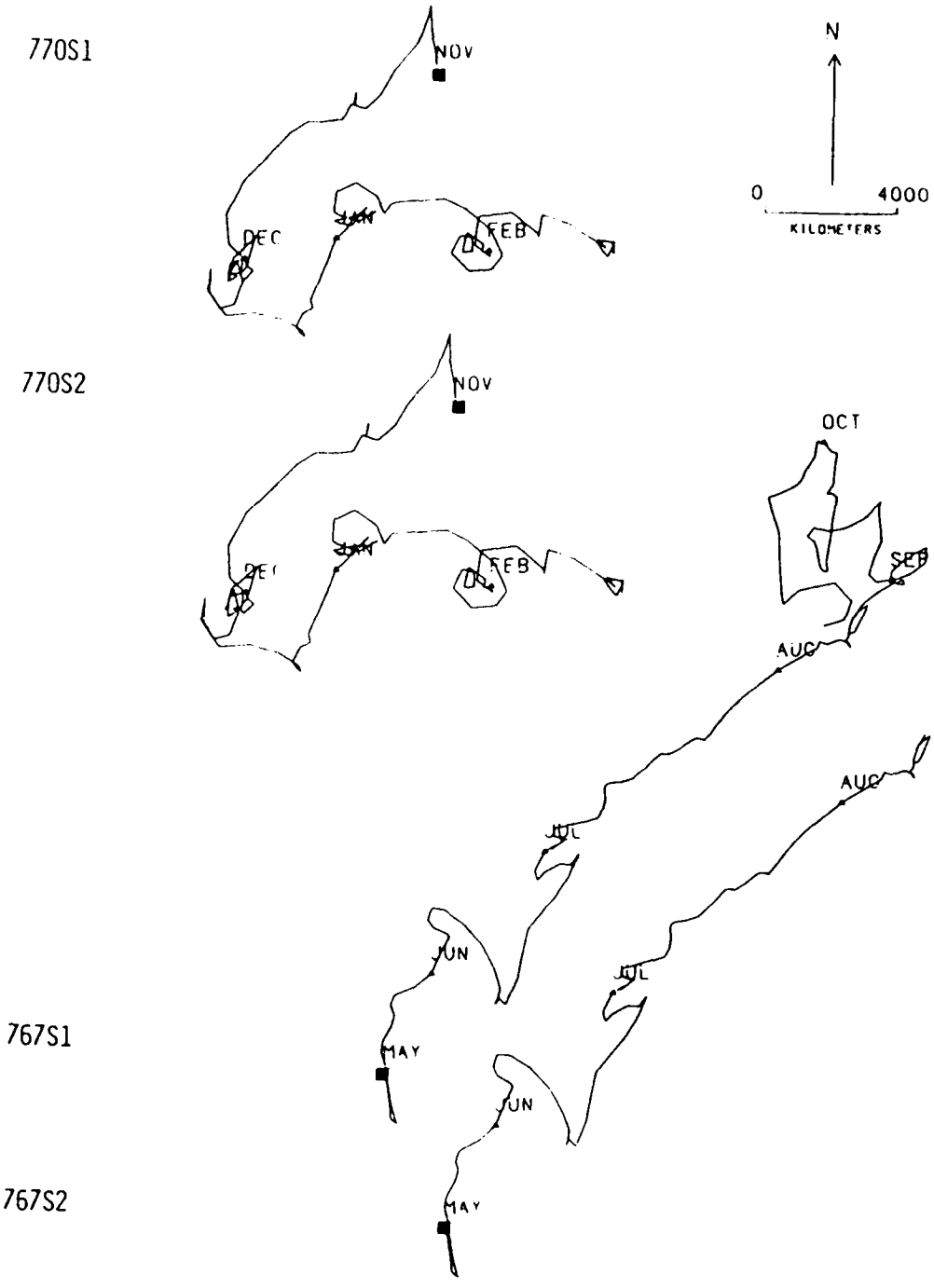
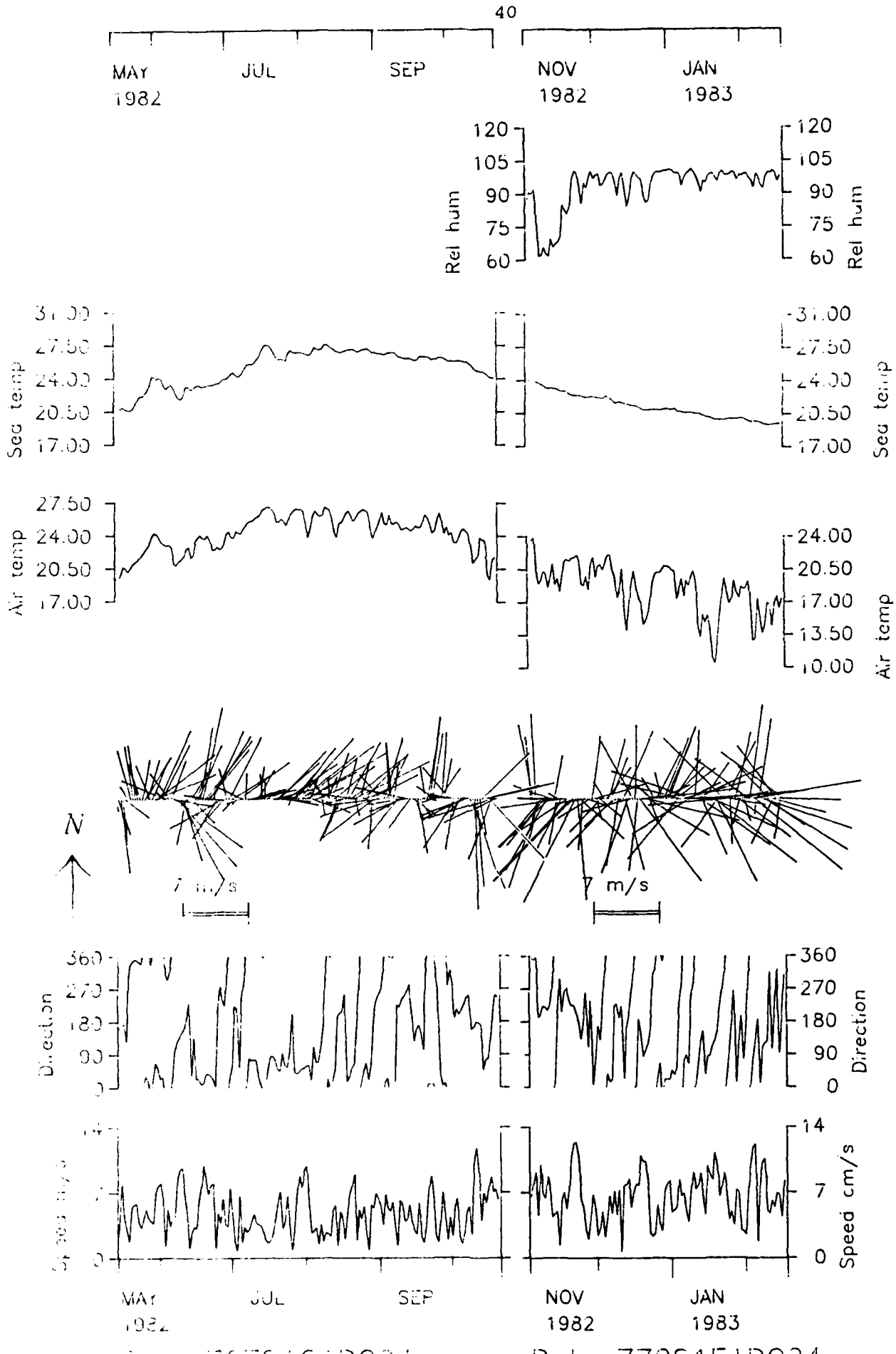


Figure 13. Provecs for the duplicate wind sensors on moorings 767 (LOTUS-3) and 770 (LOTUS-4).

SURFACE MOORINGS 767 AND 770
METEOROLOGICAL DATA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JUL
SEP
NOV
1982
JAN
1983
Rel hum
120
105
90
75
60
Sea temp
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24.00
20.50
17.00
Air temp
27.50
24.00
20.50
17.00
13.50
10.00
N
7 m/s
Direction
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Speed cm/s
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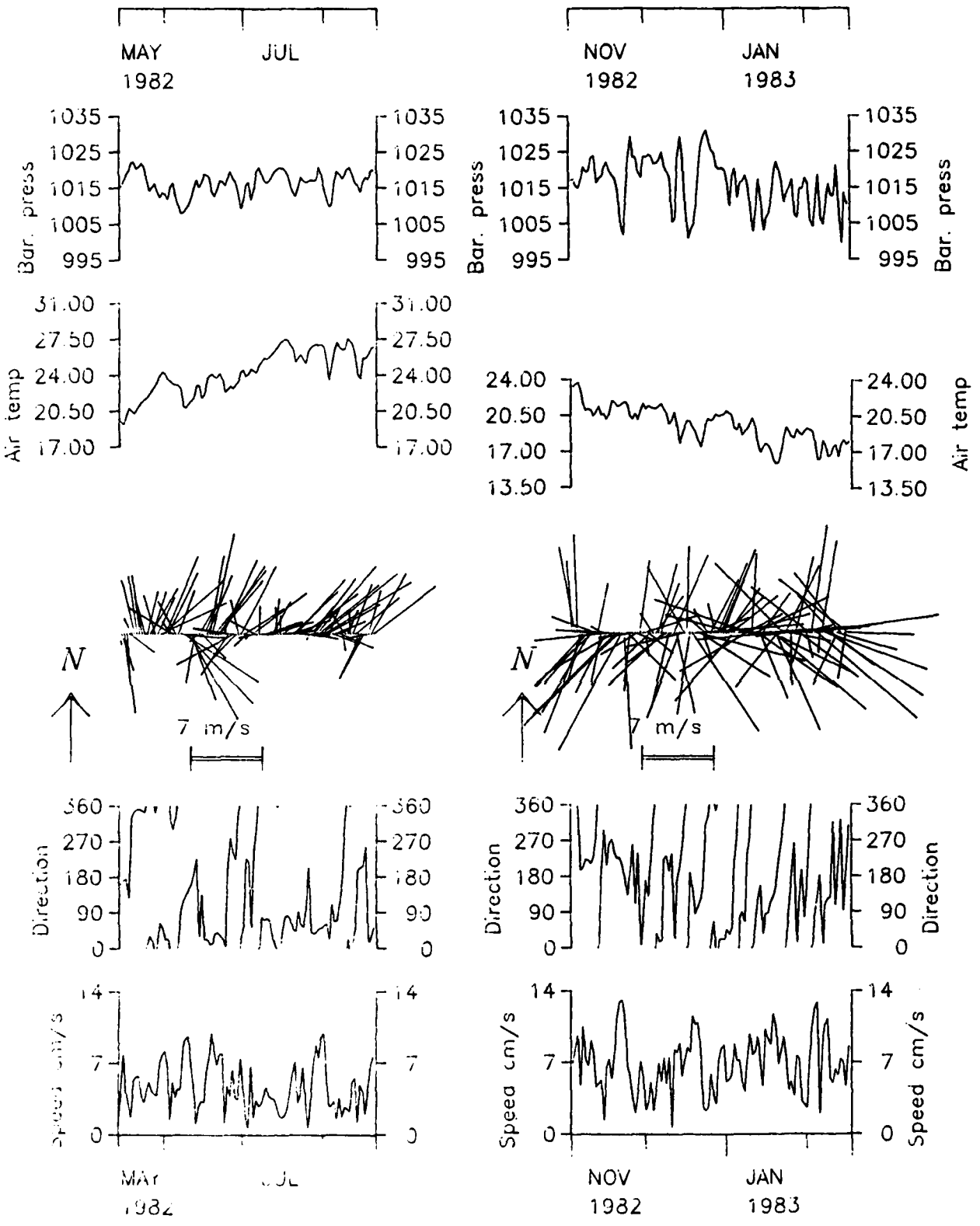
Data 770S1E1DG24



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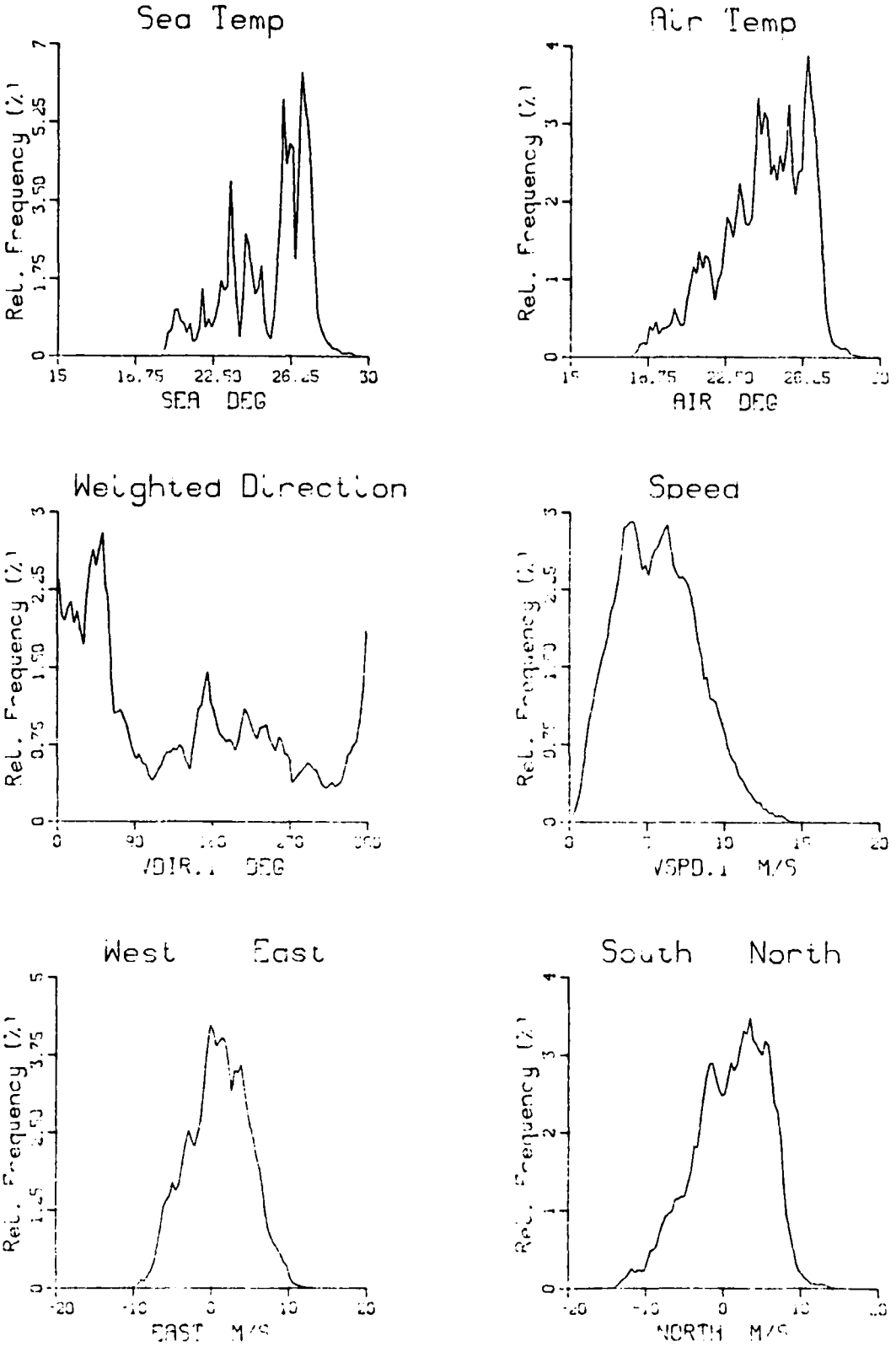

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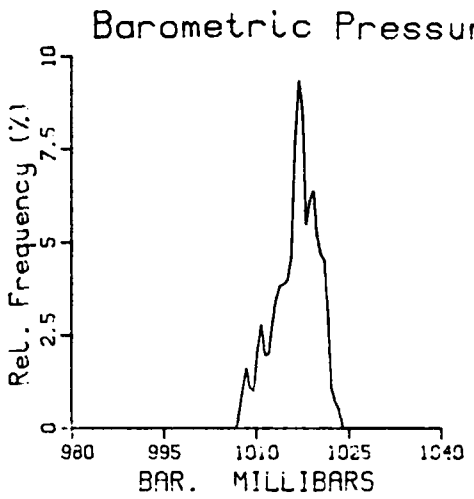

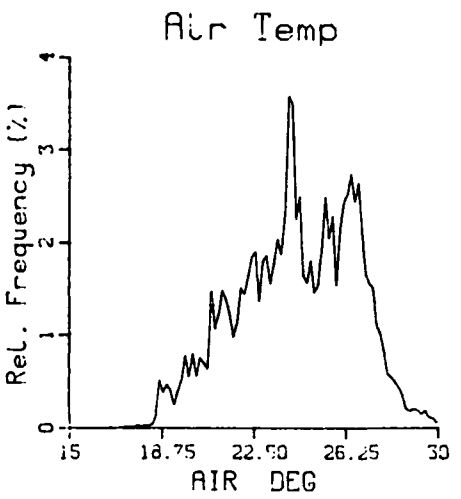

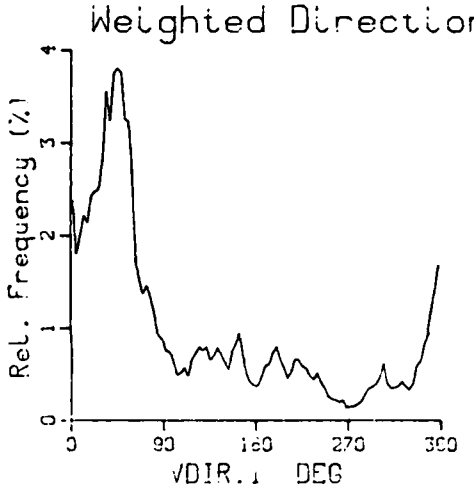

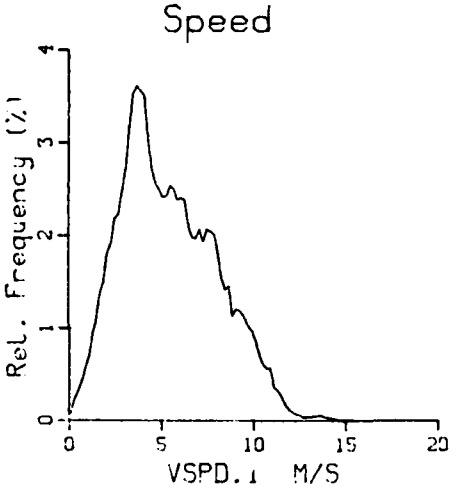

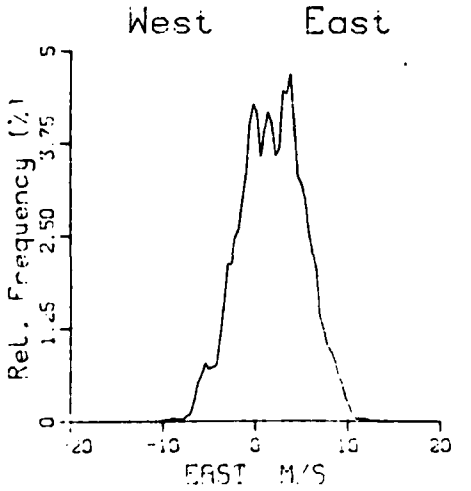

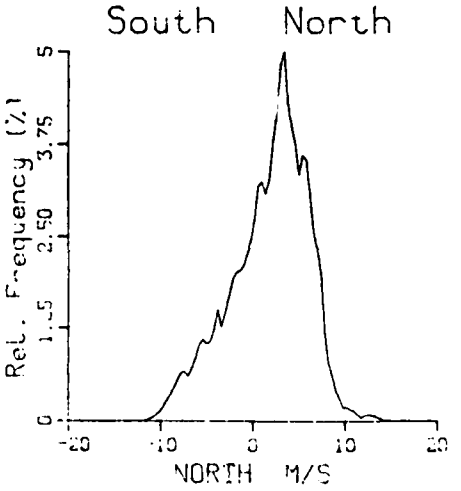

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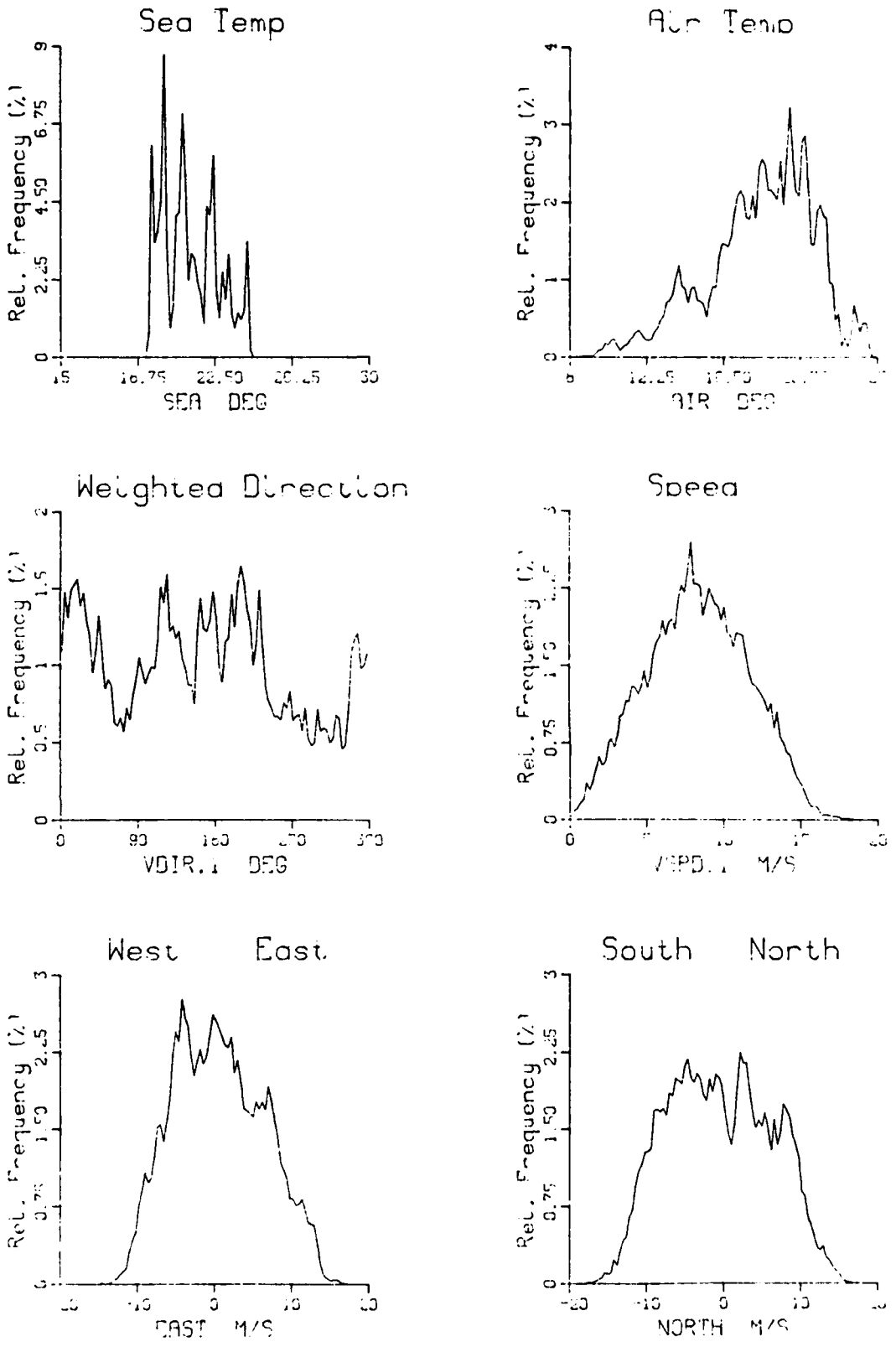

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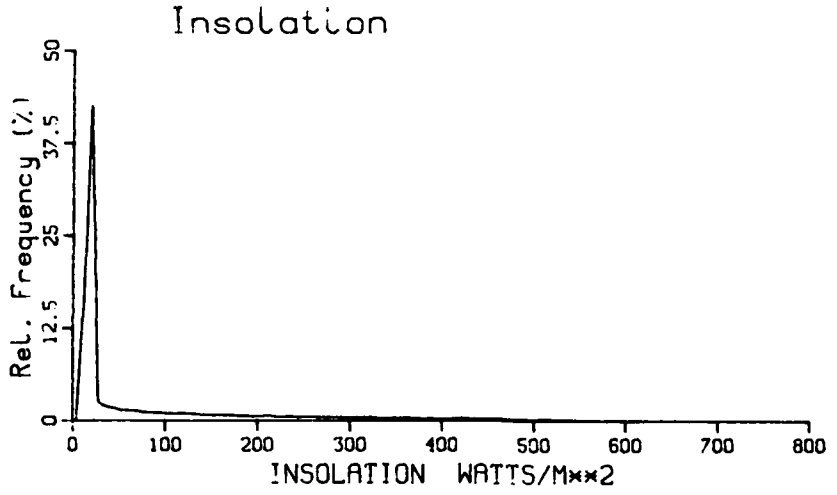

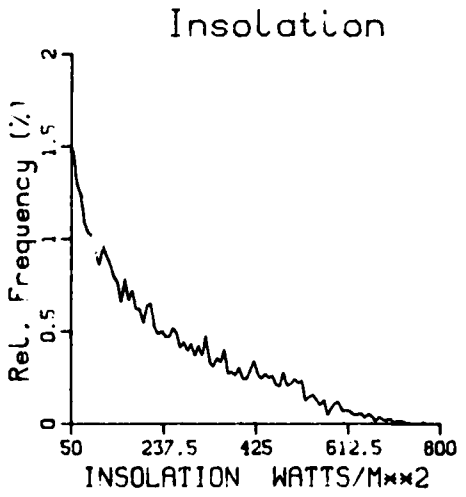

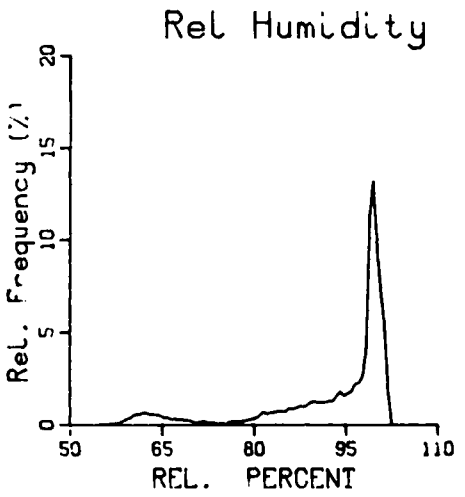

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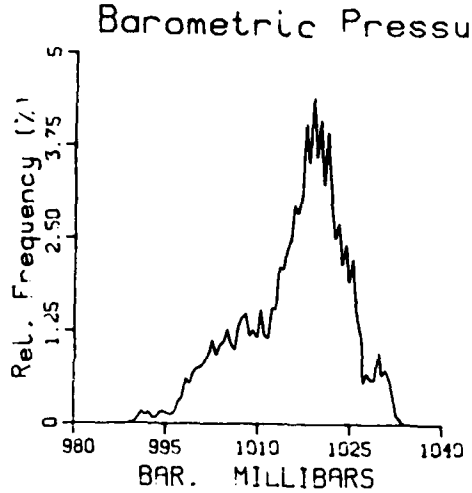

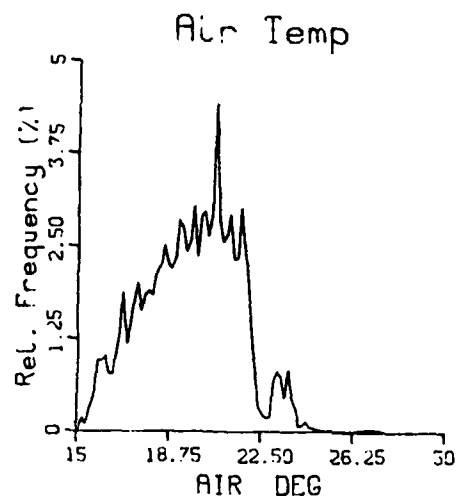

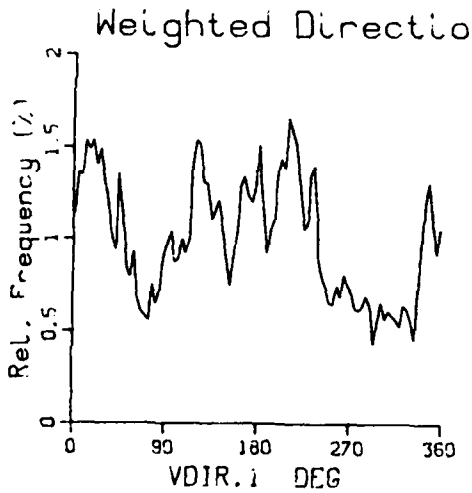

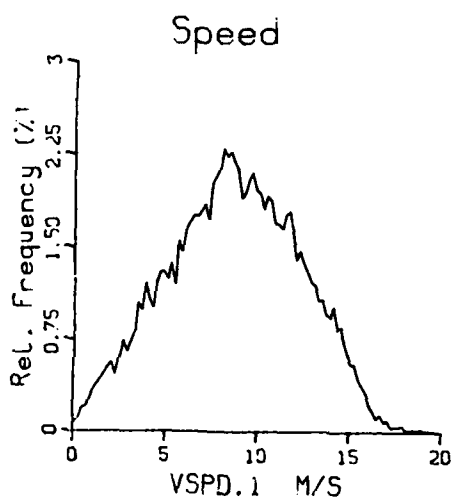

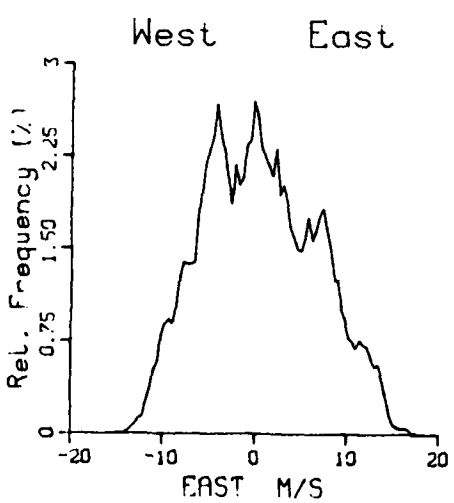

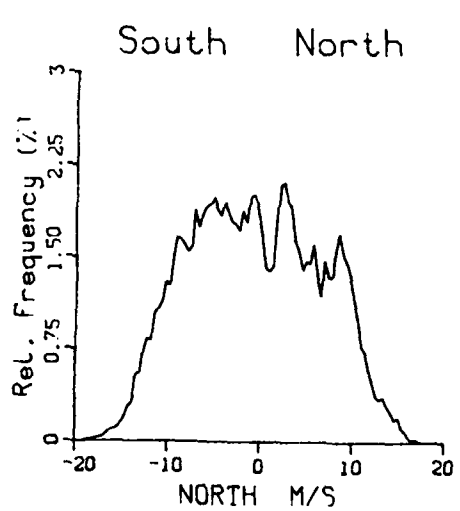

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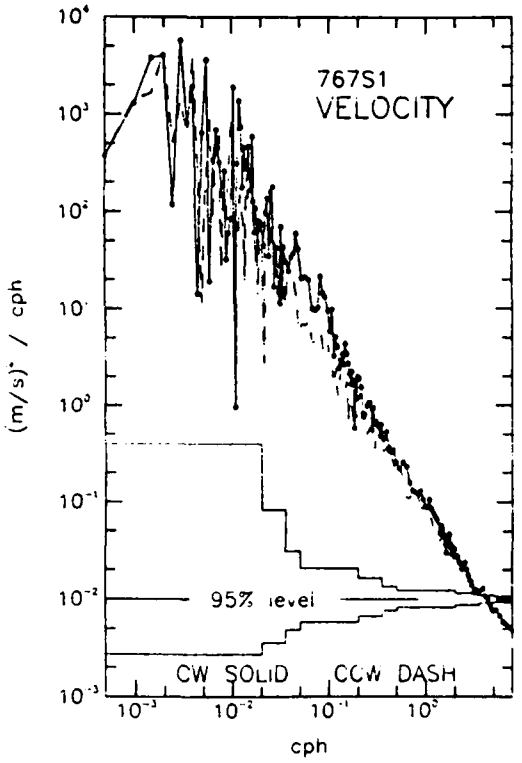
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VELOCITY
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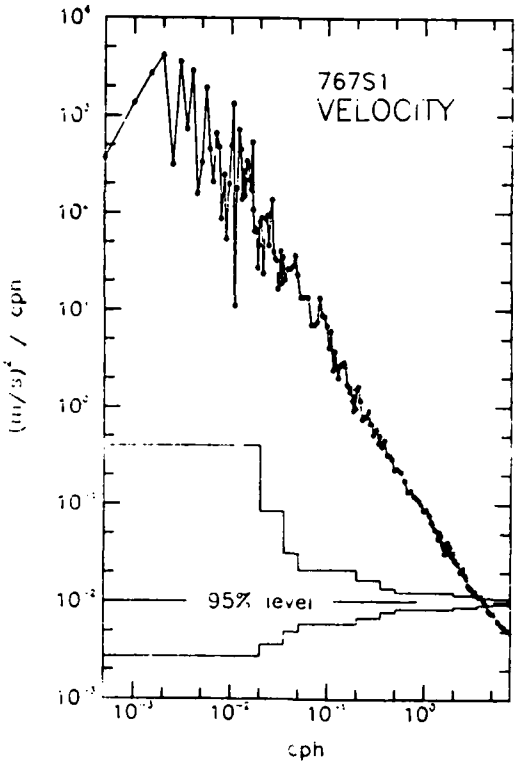
CW SOLID CCW DASH
cph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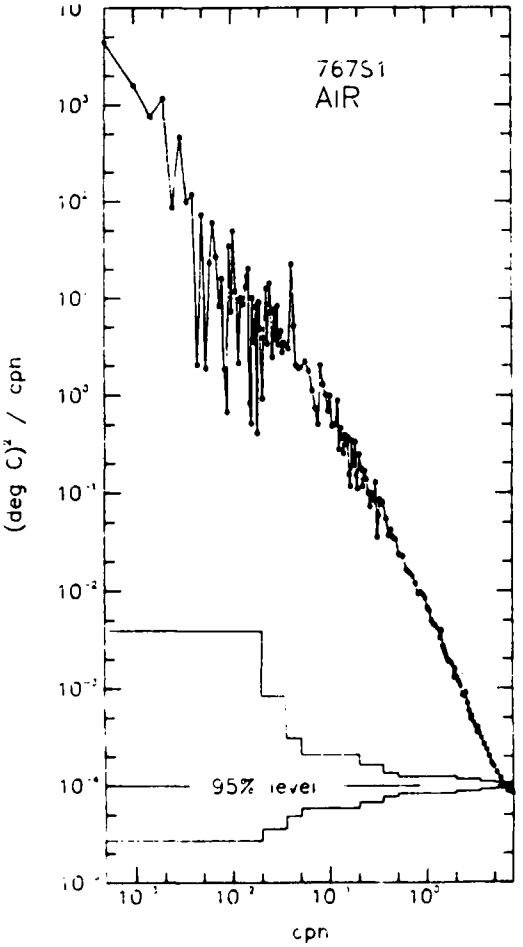
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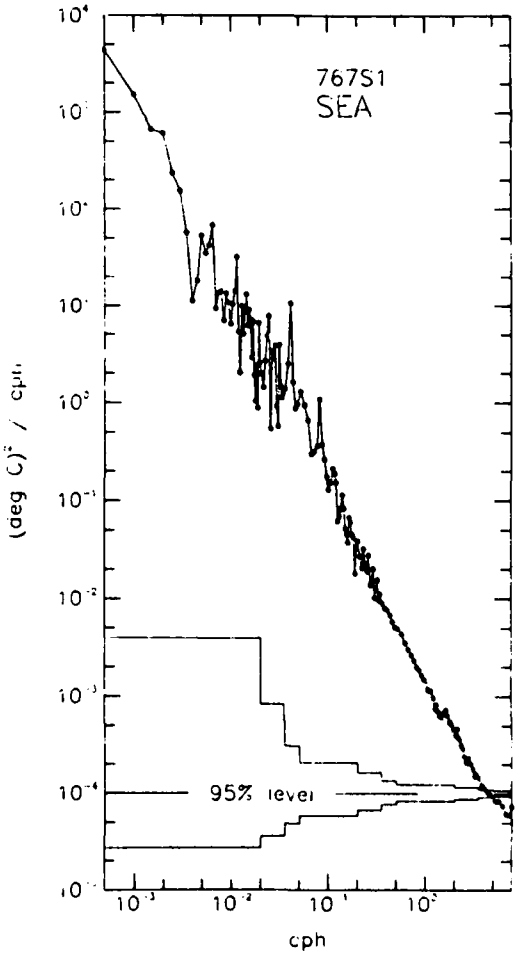
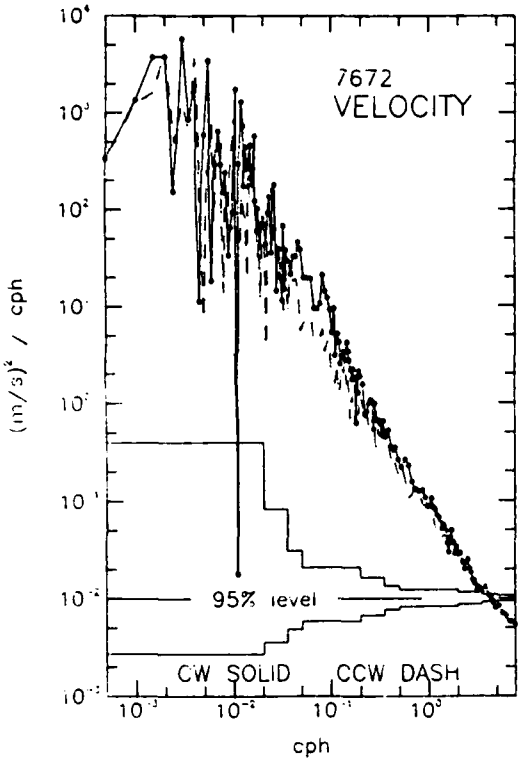
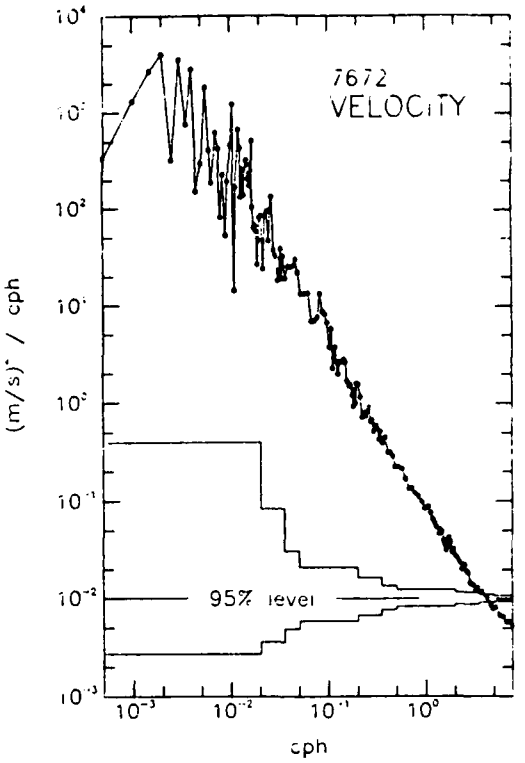
AIR
95% level
cpn


767S1
SEA
95% level
cph


7672
VELOCITY
95% level
CW SOLID CCW DASH
(m/s)² / cph
cph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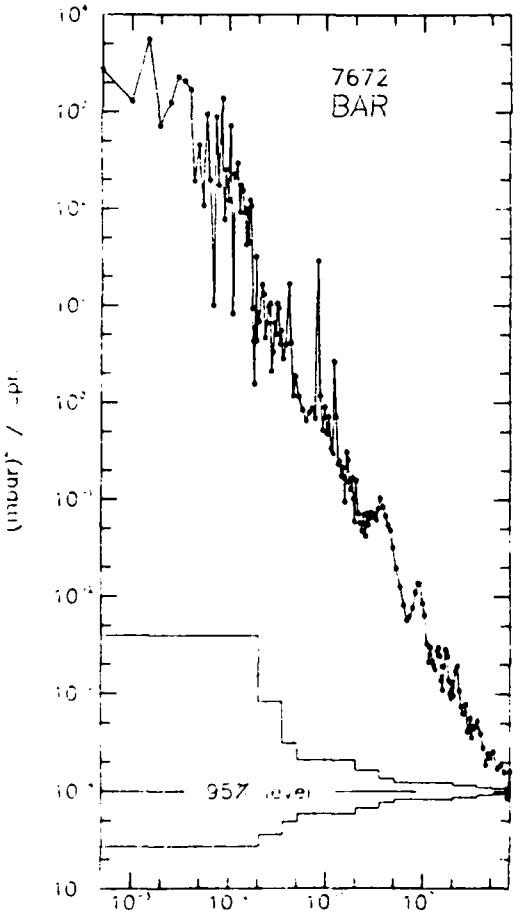
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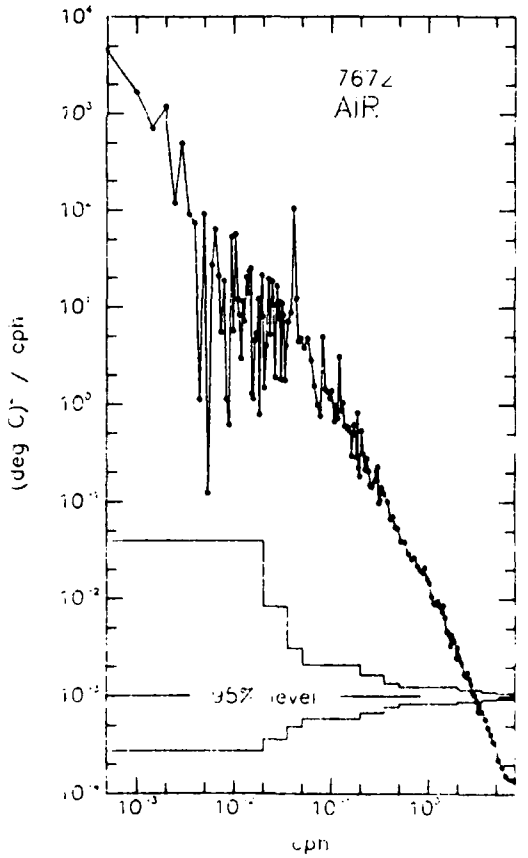
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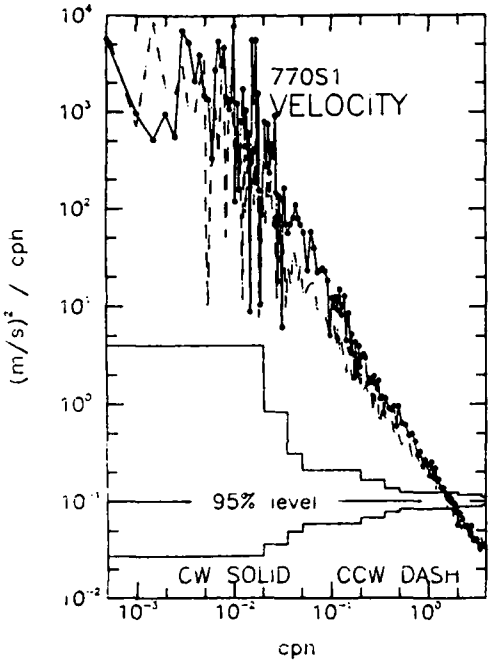
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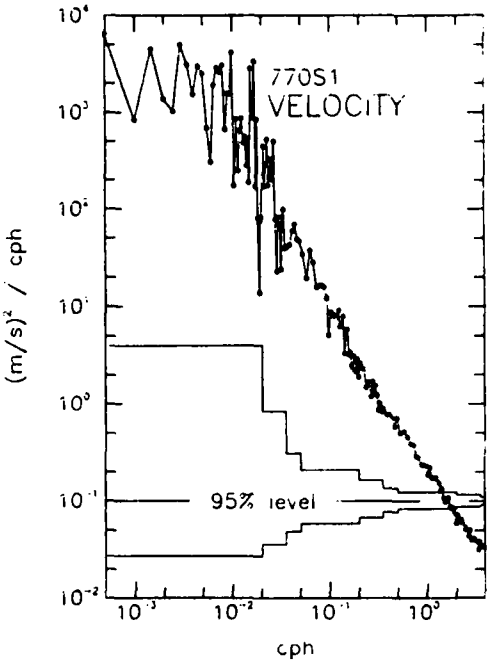
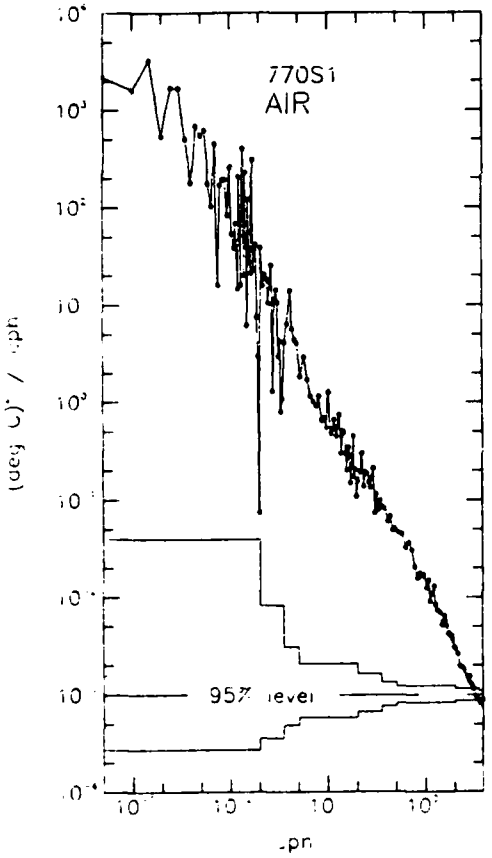
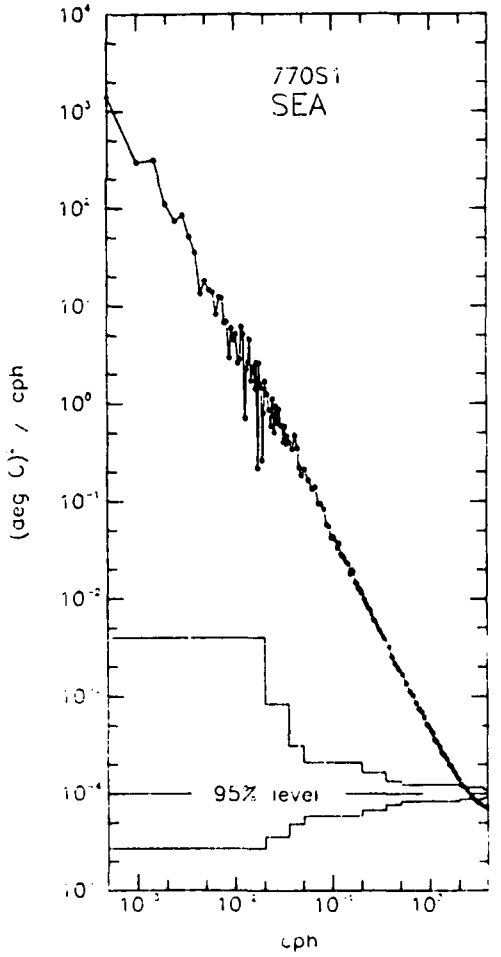
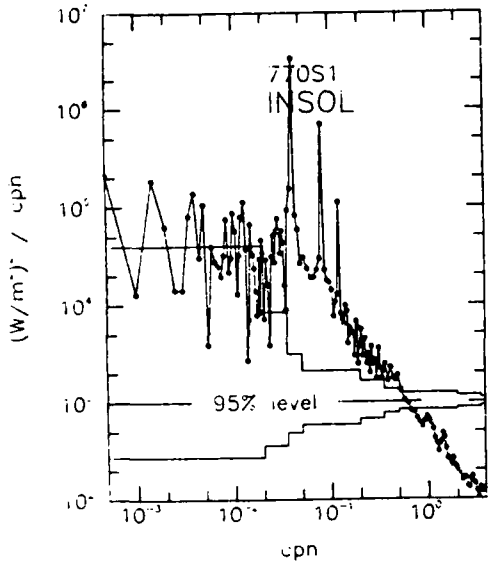
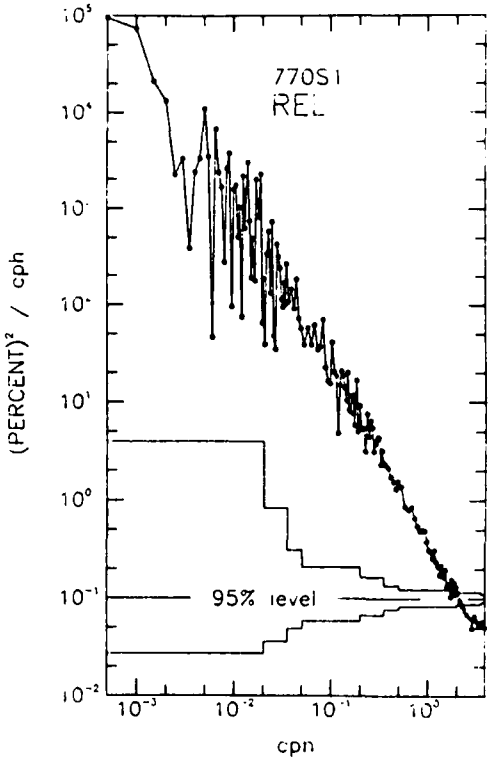
VELOCITY
95% level
CW SOLID CCW DASH
(m/s)² / cph
cph

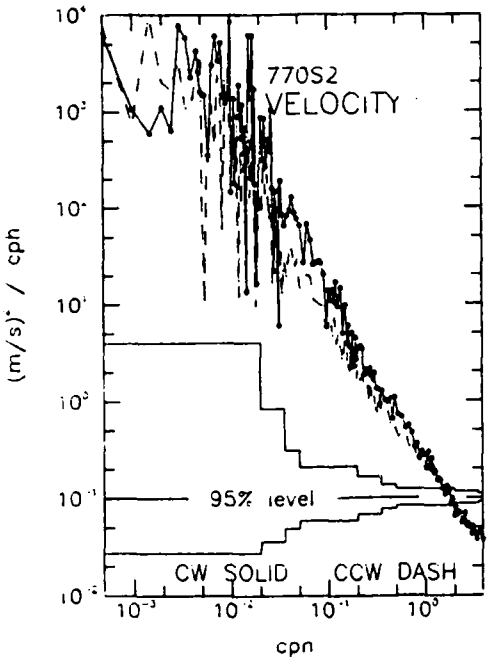

770S1
VELOCITY
95% level
(m/s)² / cph
cph

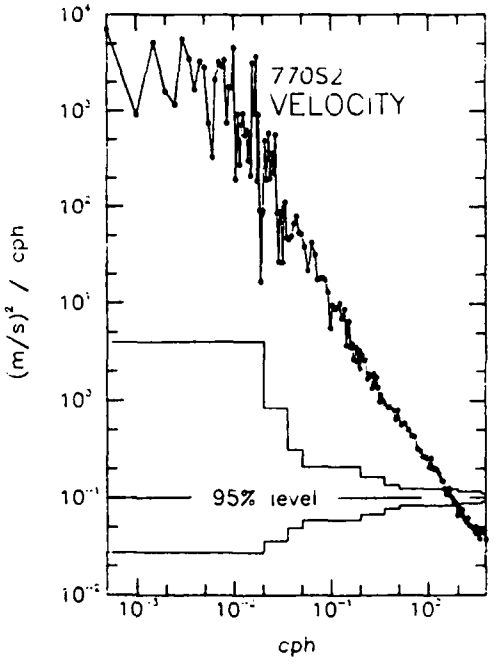

770S1
AIR
95% level
cph

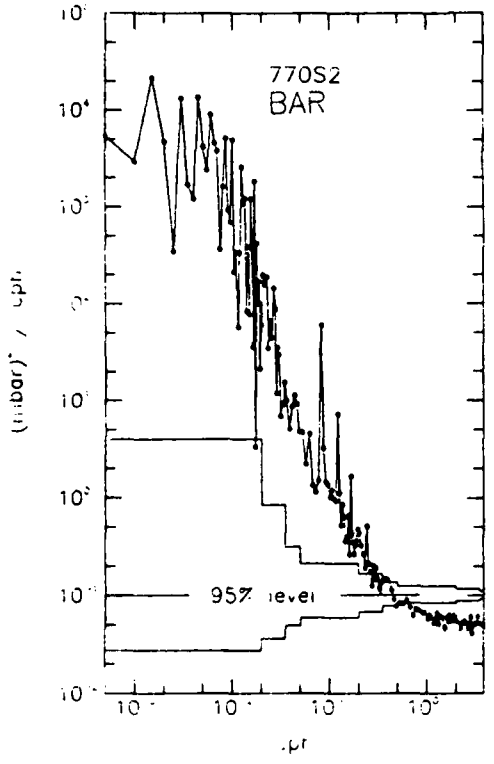

770S1
SEA
95% level
(deg C)² / cph
cph

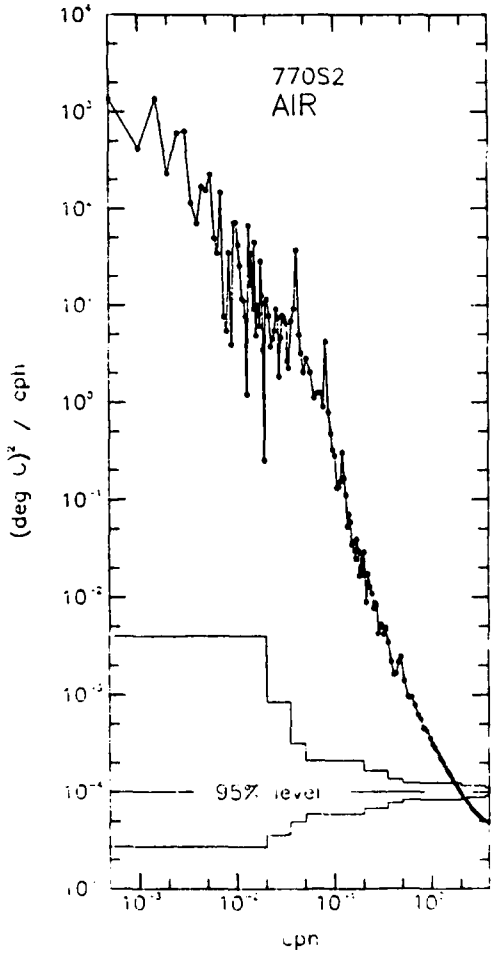

770S1
INSOL
95% level
(W/m²)² / cpn
cpn


770S1
REL
95% level
(PERCENT)² / cph
cpn


770S2
VELOCITY
95% level
CW SOLID CCW DASH
(m/s)² / cph
cpn


770S2
VELOCITY
95% level
(m/s)² / cph
cph

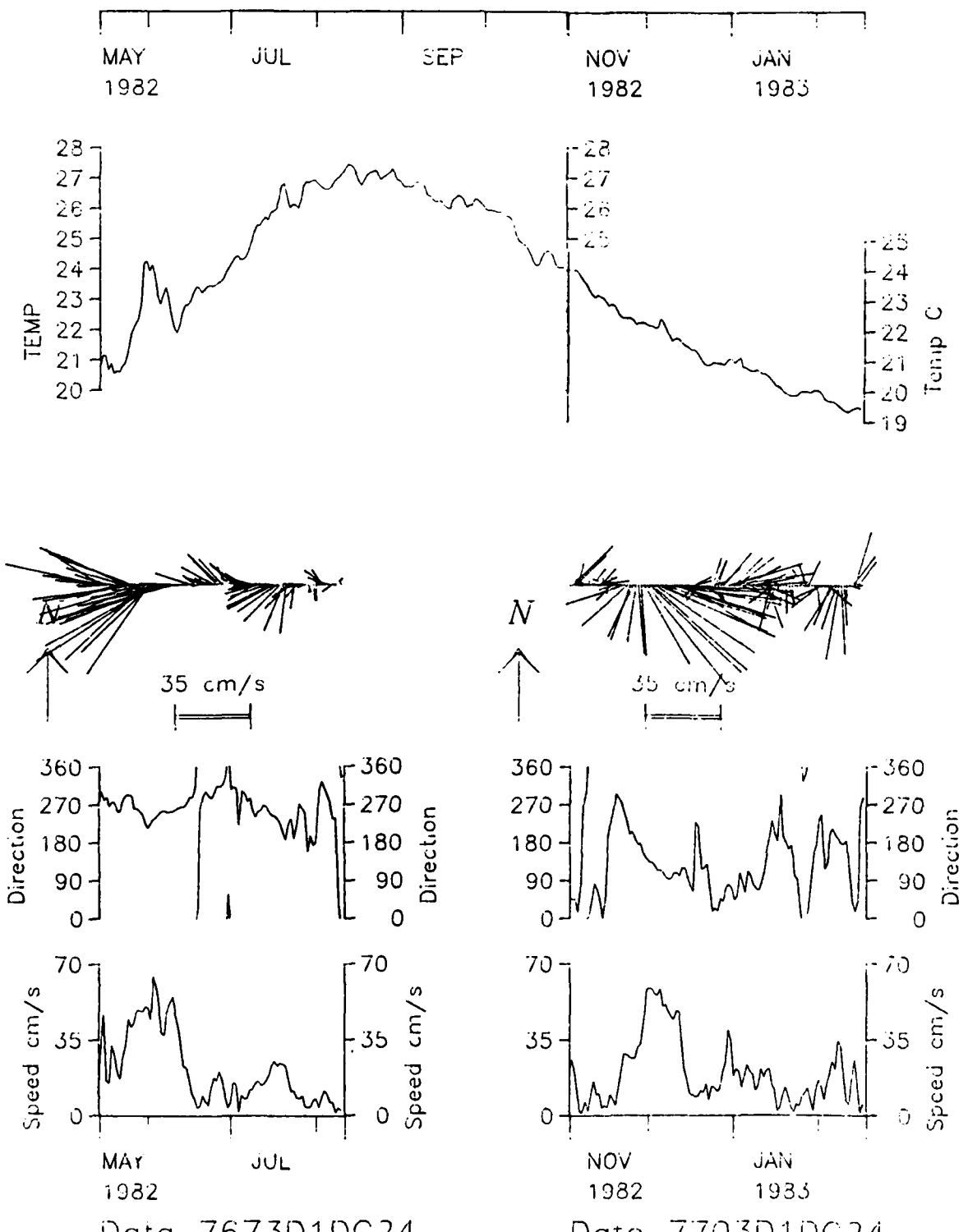

770S2
BAR
95% level
cpn


770S2
AIR
95% level
(deg C)² / cph
cph

SURFACE MOORINGS 767 AND 770

NEAR-SURFACE MOORING 766
WITH SUBSURFACE MOORINGS 764 AND 765
INCLUDED BY DEPTH.

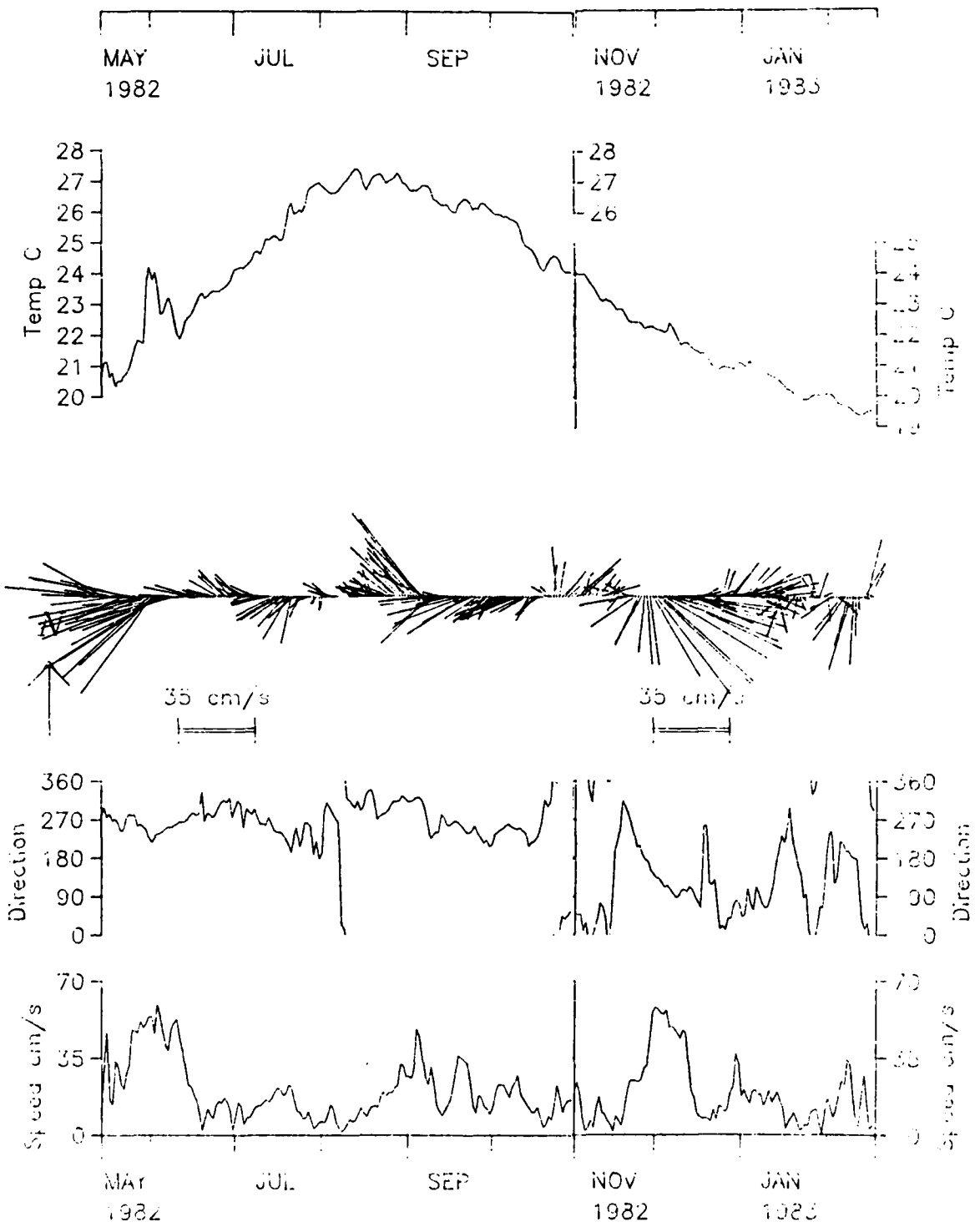
TIME SERIES



Data 7673D1DG24

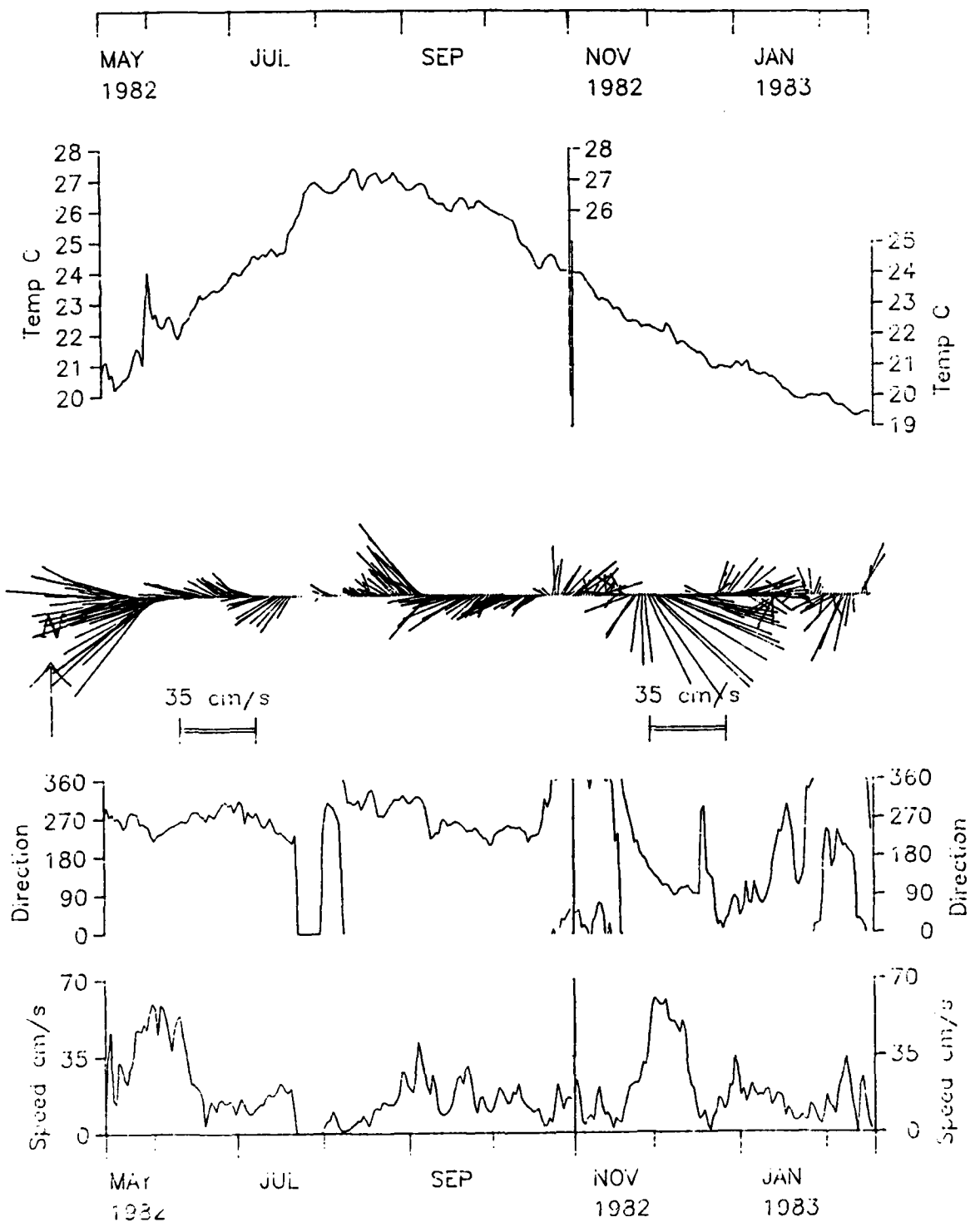
Data 7703D1DG24

Depth 5m



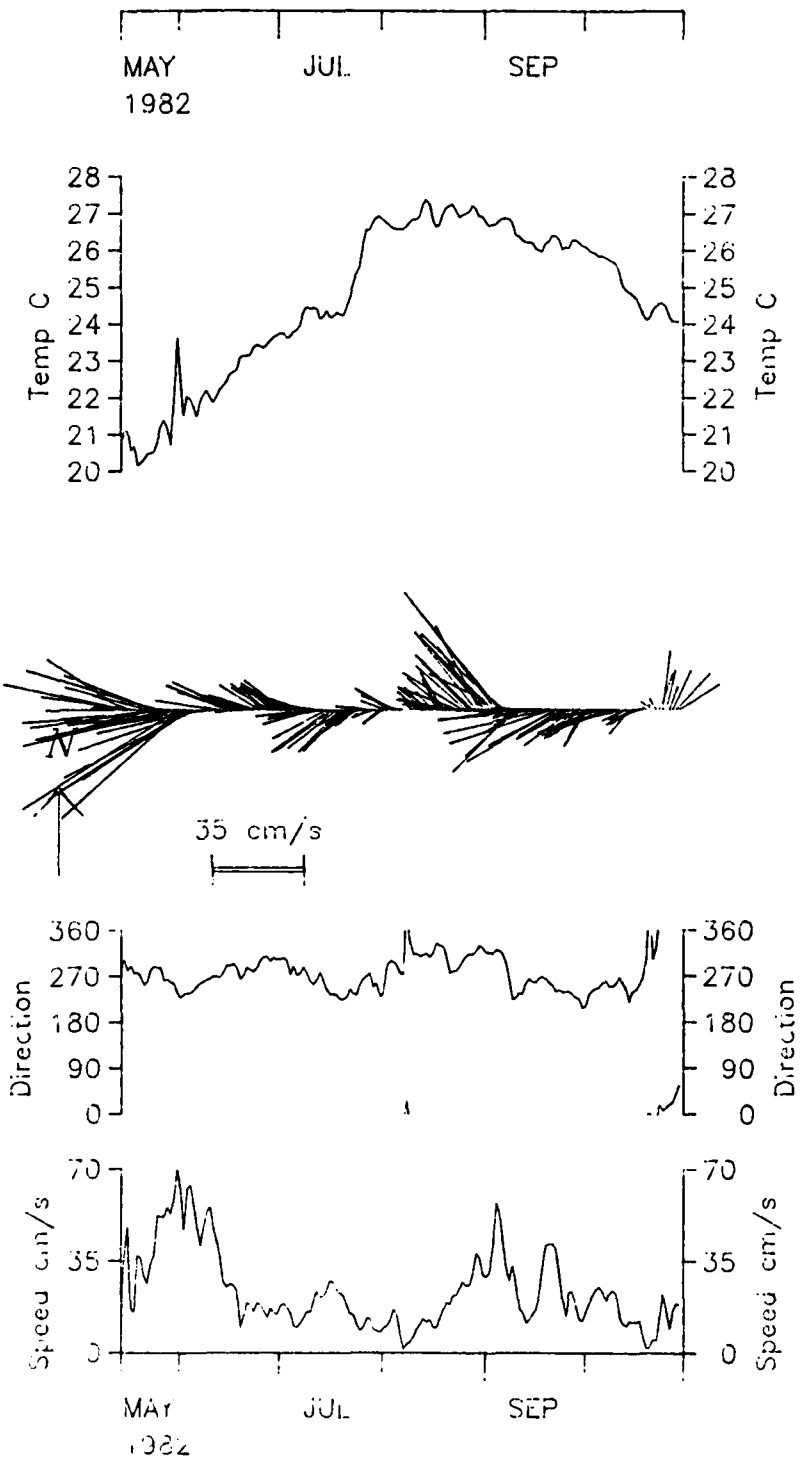
Data 7674C1DG24 Data 7704D1DG24

Depth 10m

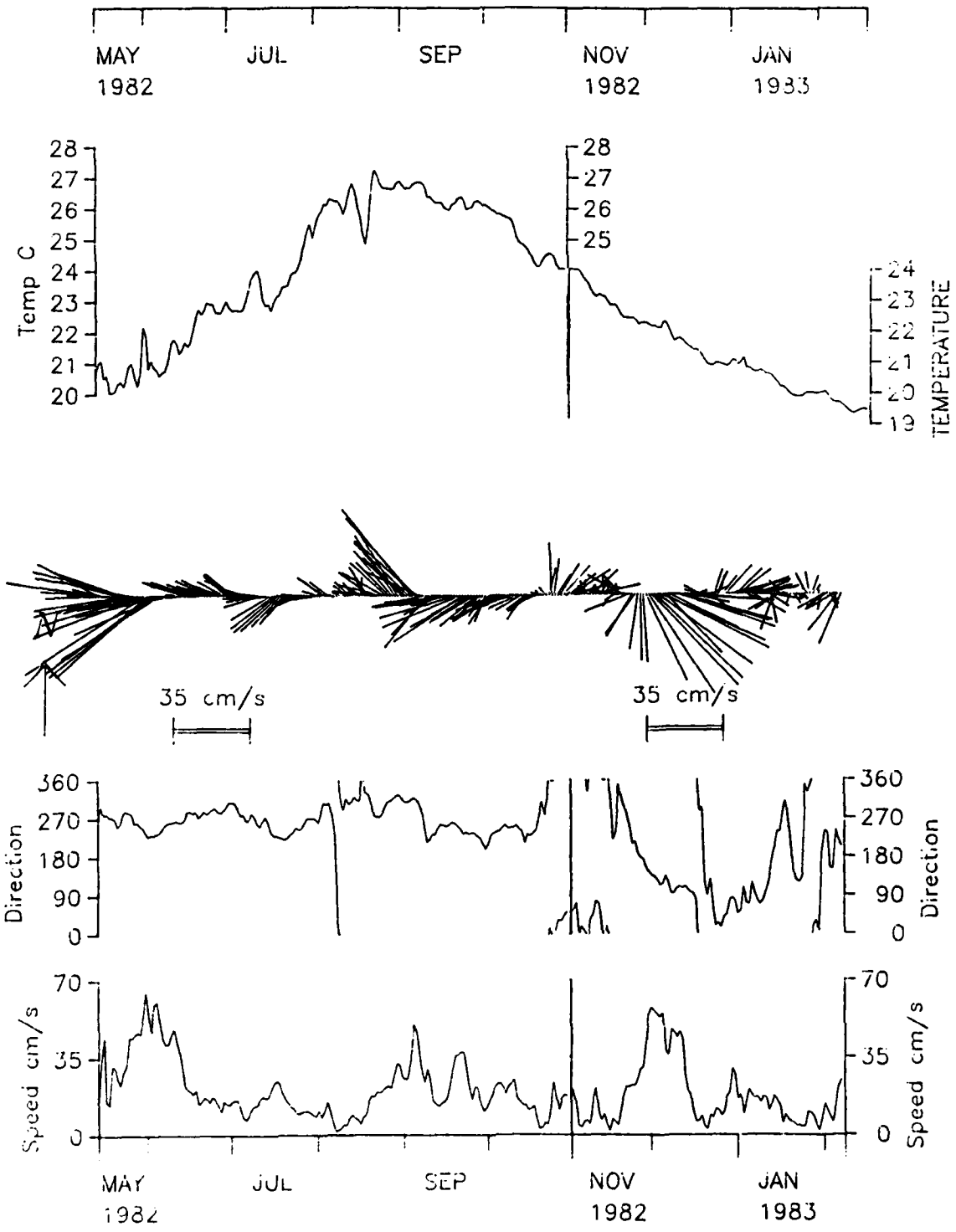


Data 7675C1DG24 Data 7705D1DG24

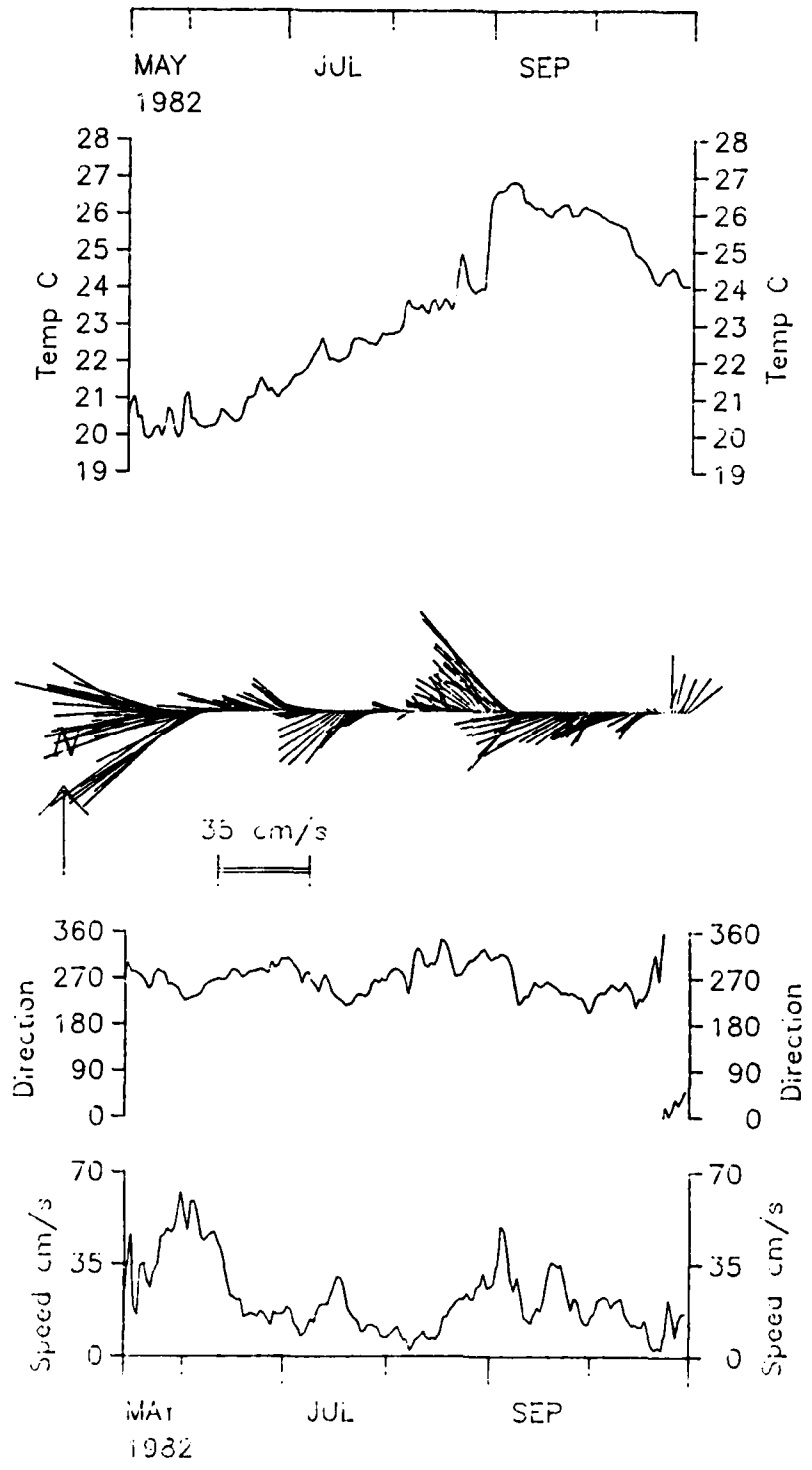
Depth 15 m



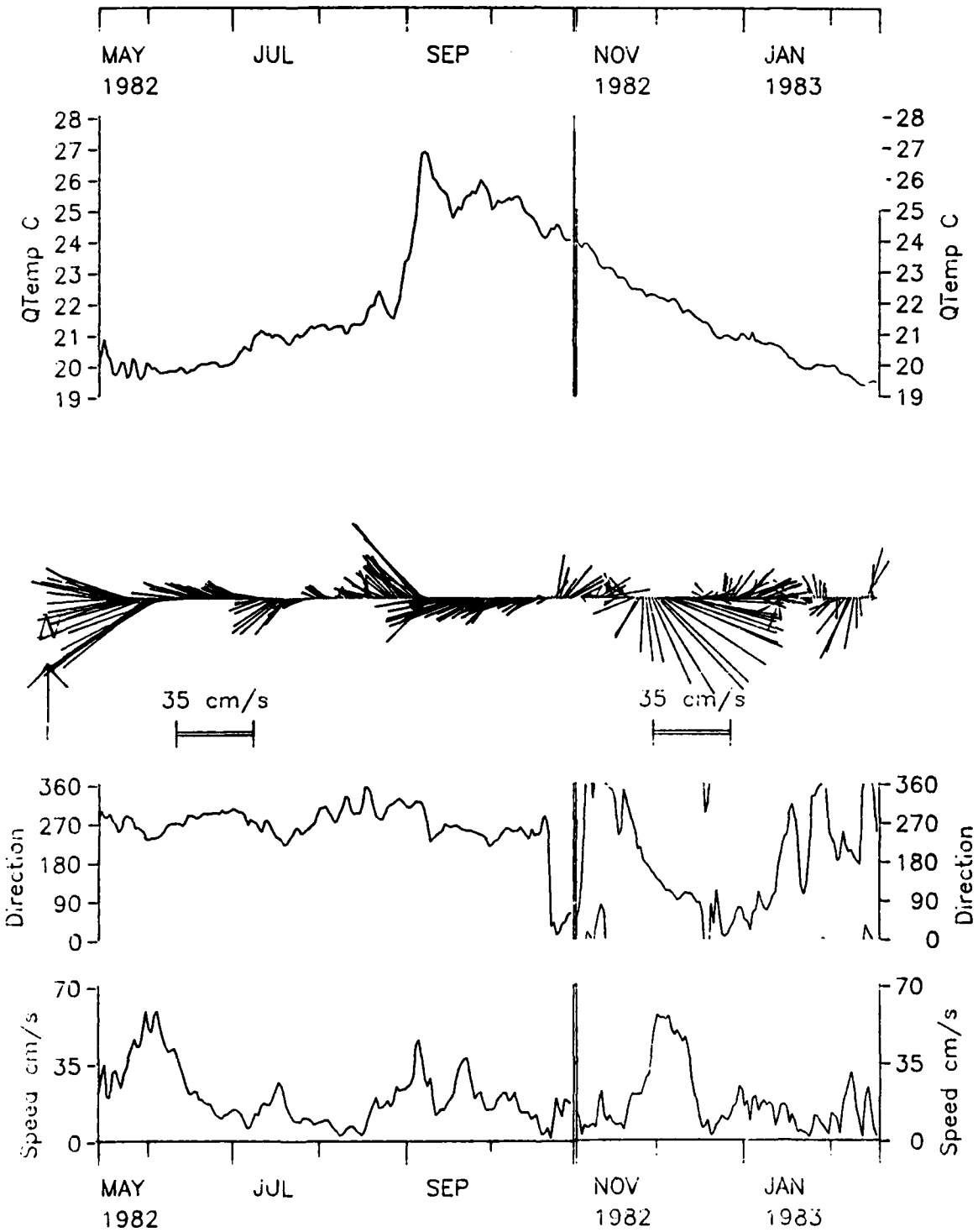
Data 7676C1DG24 Depth 20m


MAY
1982
JUL
SEP
NOV
1982
JAN
1983
Temp C
28
27
26
25
24
23
22
21
20
19
TEMPERATURE
35 cm/s
35 cm/s
Direction
360
270
180
90
0
Speed cm/s
70
35
0
Data 7677C1DG24
Data 7706D1DG24

Depth 25m

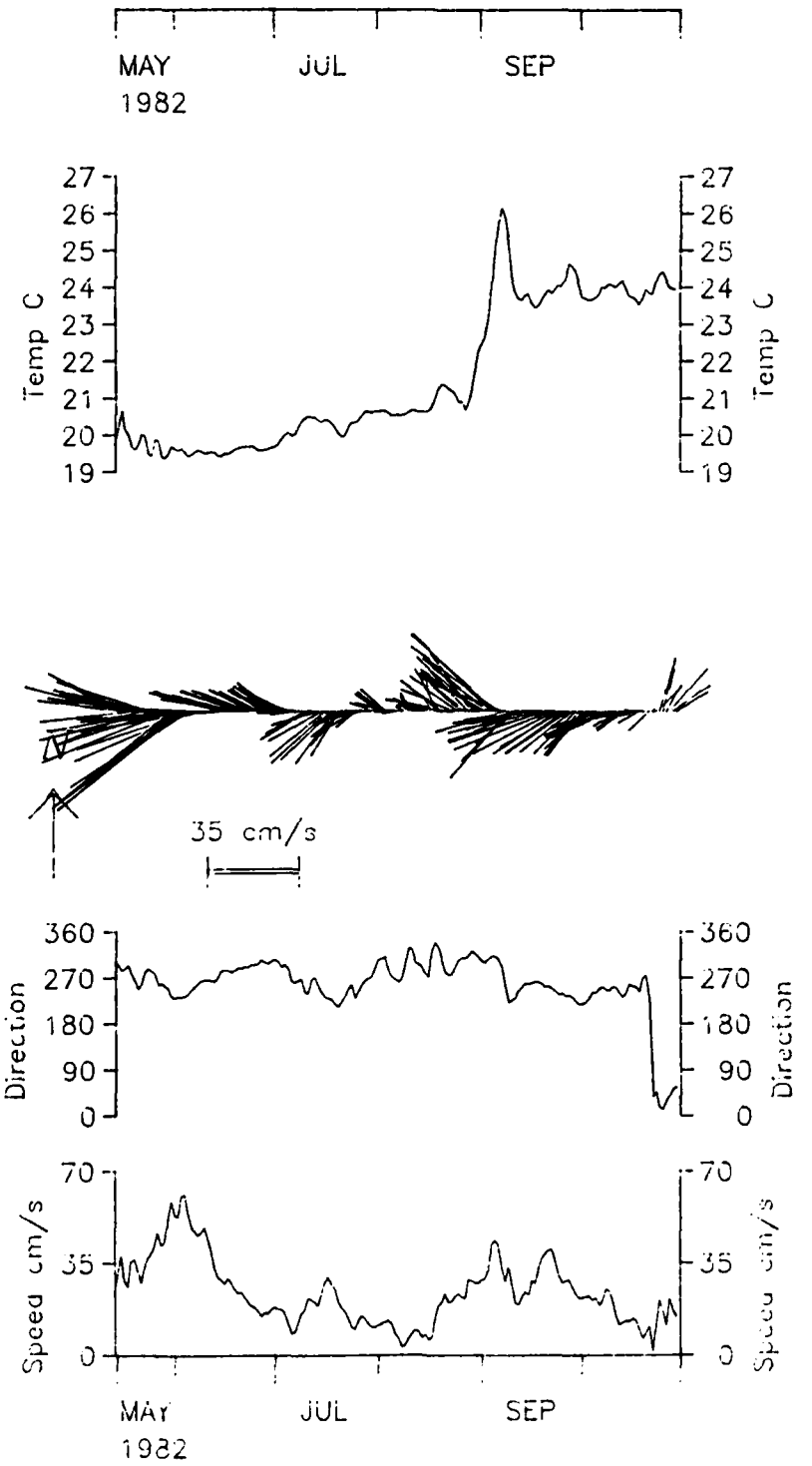


Data 7678C1DG24 Depth 35m

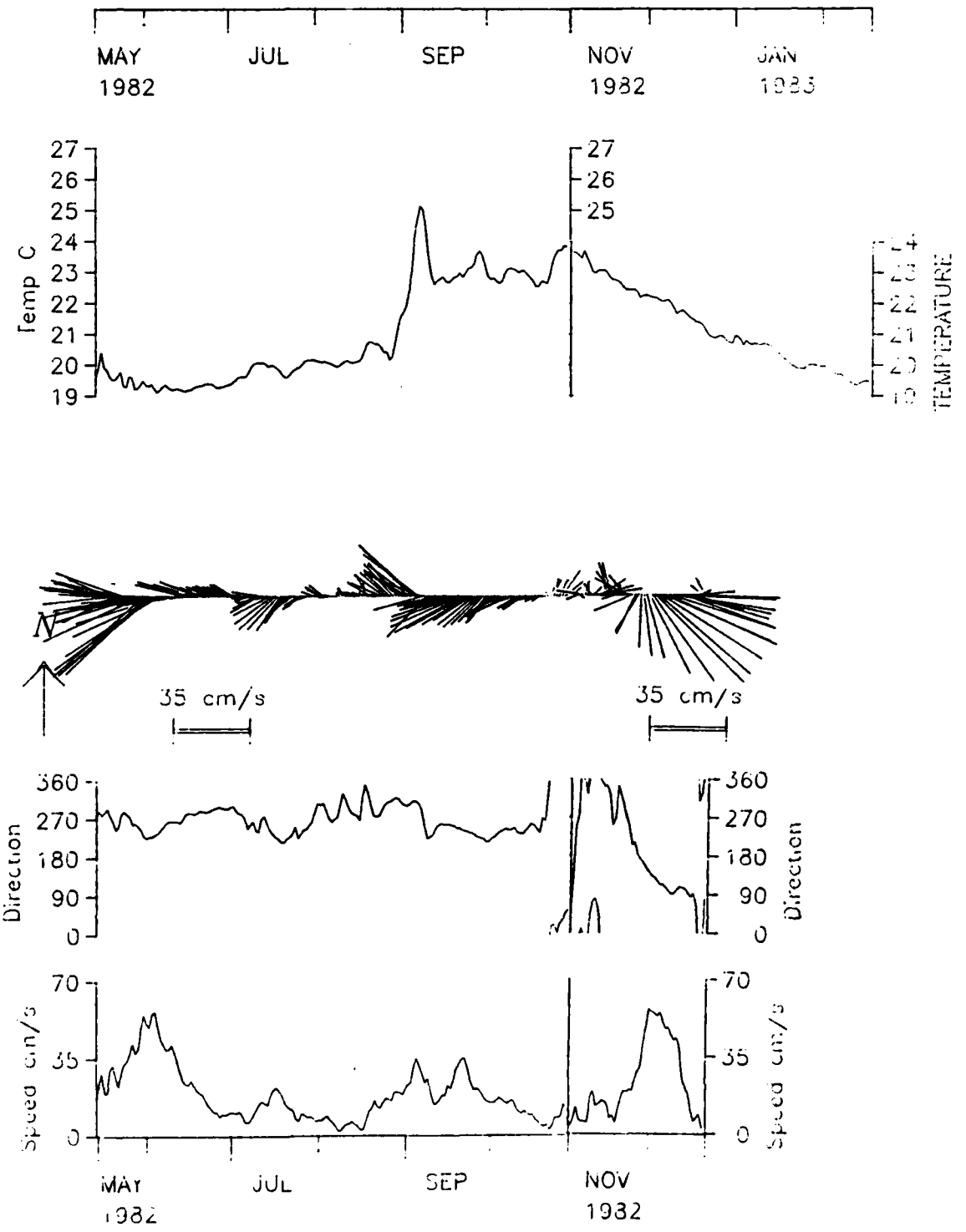


Data 7679E1DG24 Data 7707D1DG24

Depth 50m

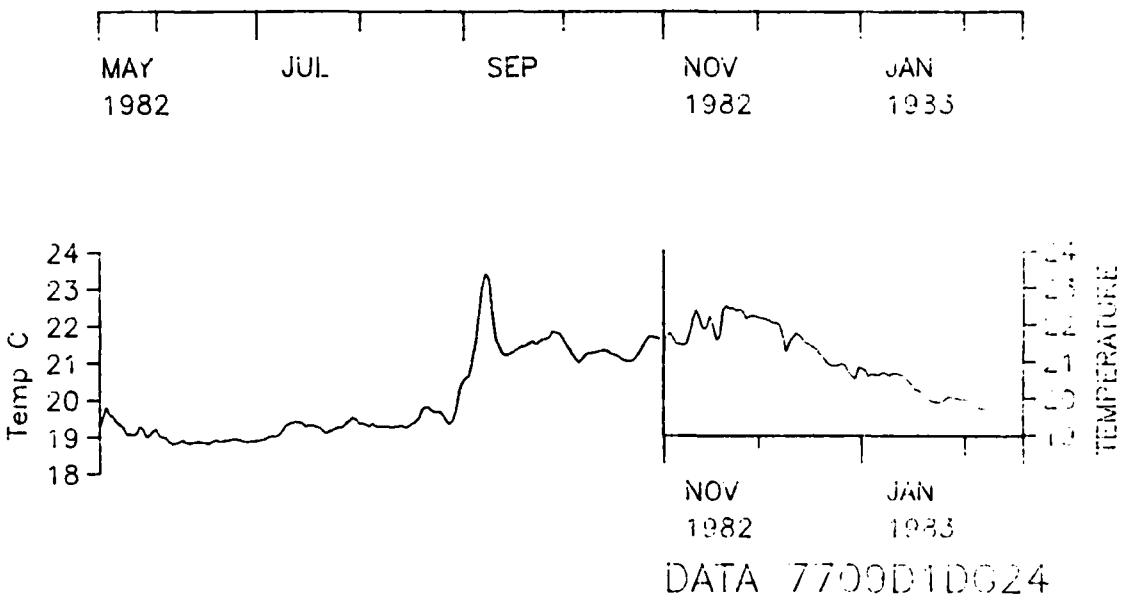


Data 76710C1DG24 Depth 65m

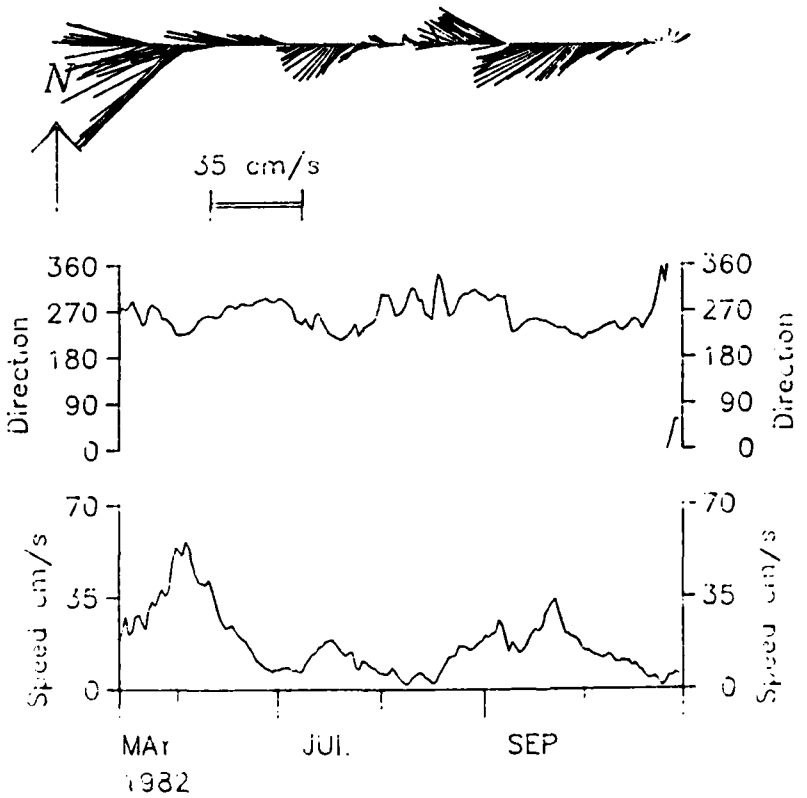


Data 76711C1DG24 Data 7708D1DG24

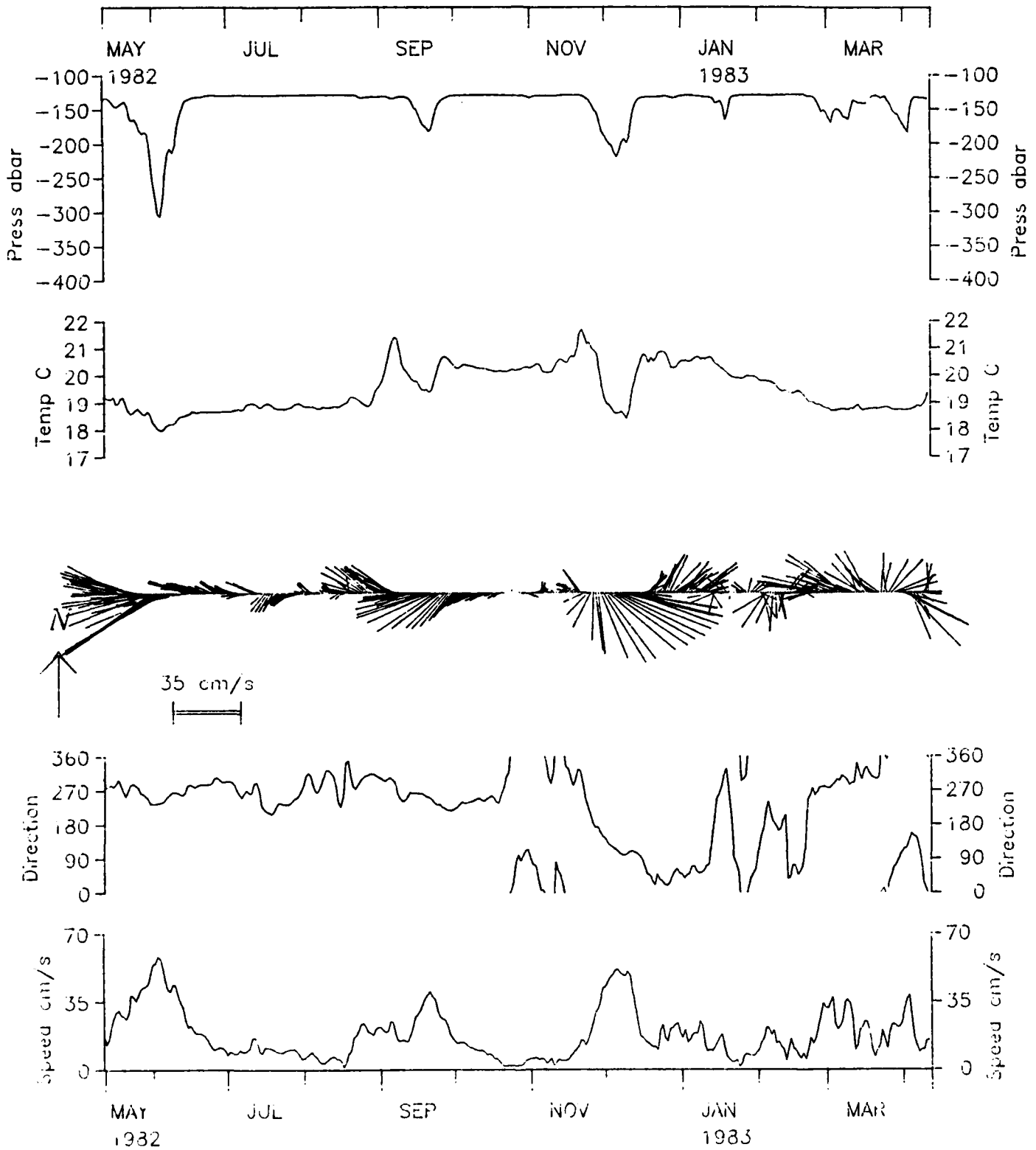
Depth 75m



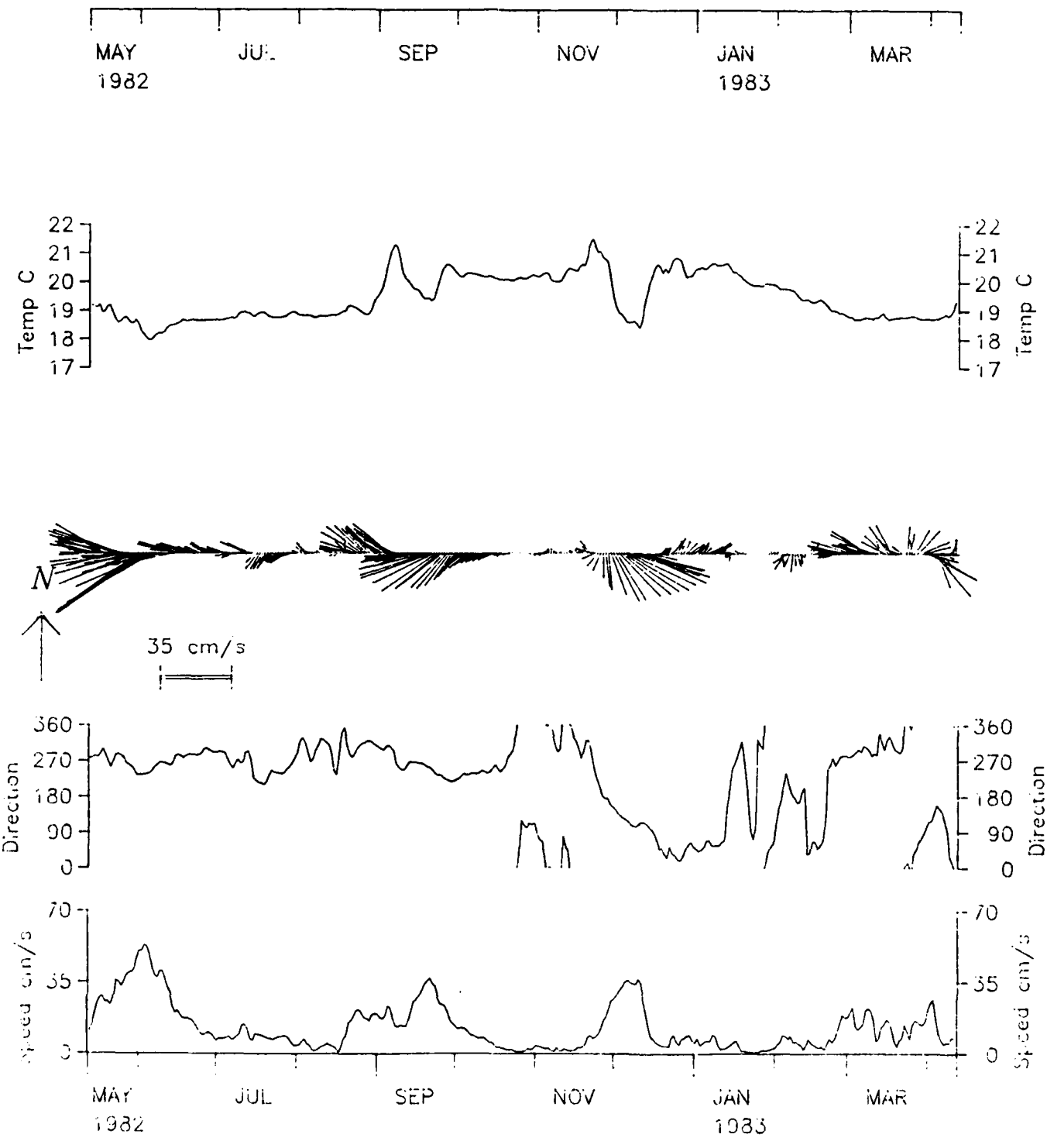
DATA 7709D1DG24



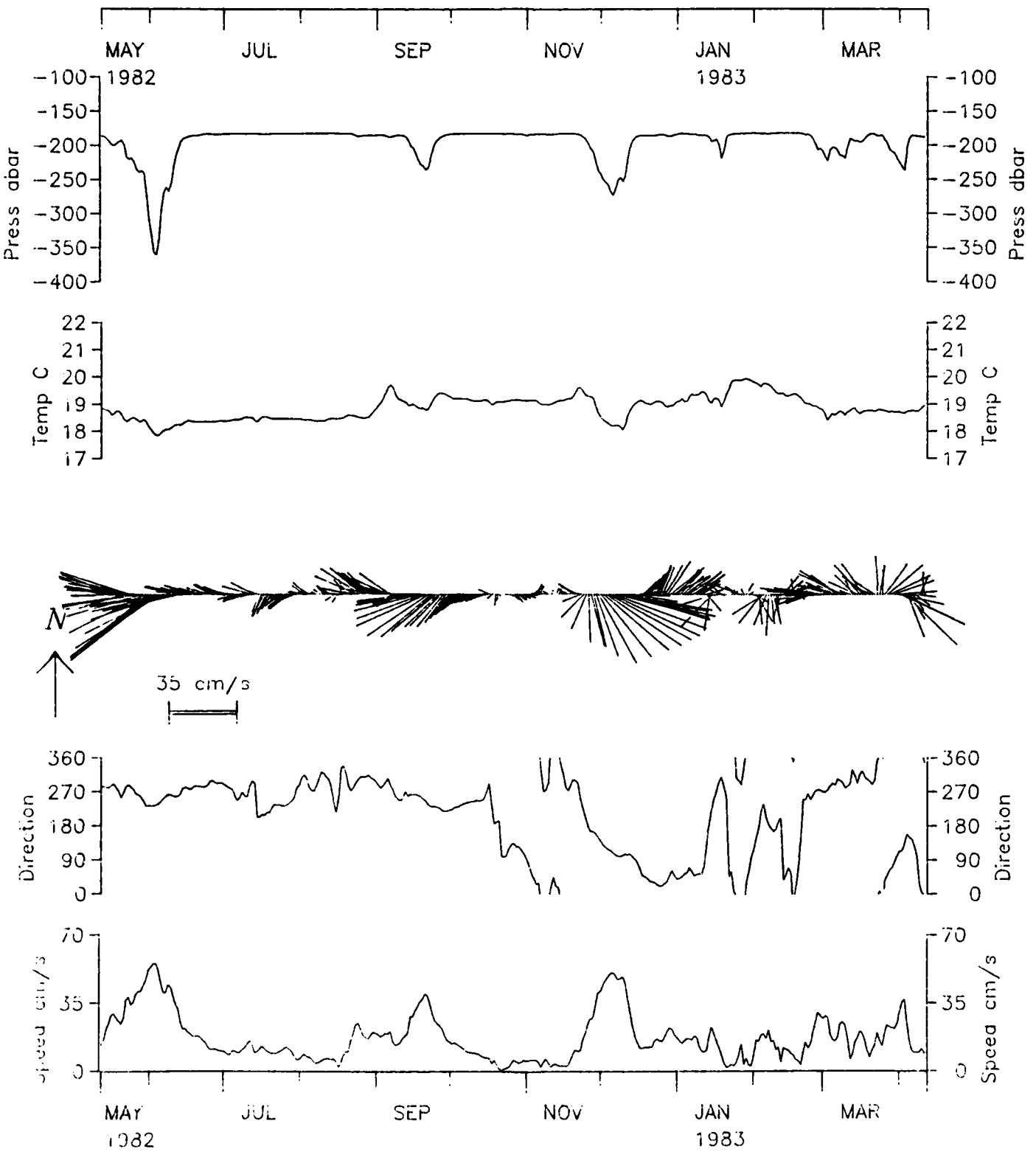
Data 76712C1DG24 Deptn 100m



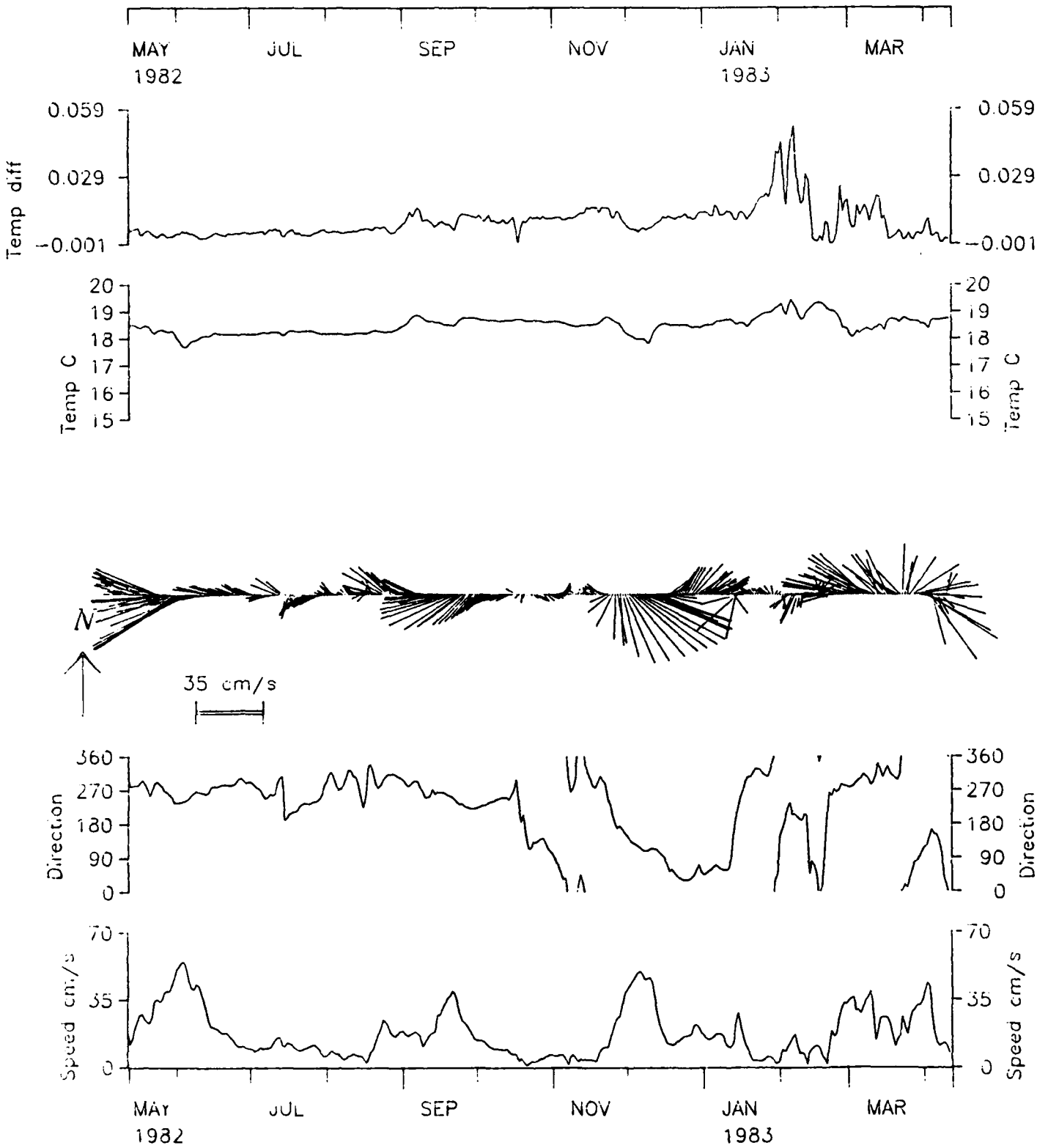
Data 7661C1DG24 Deptn 127m



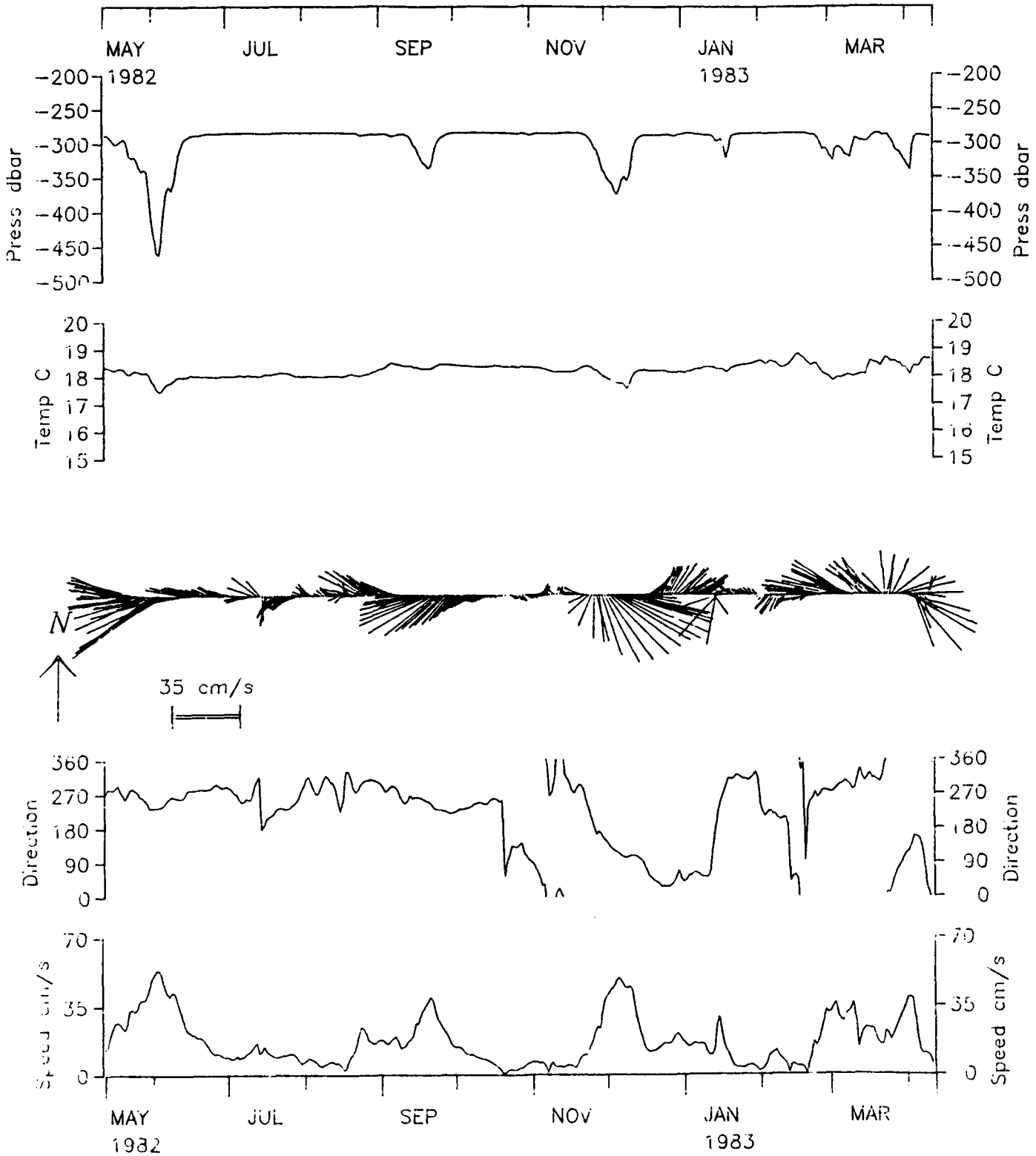
Data 7662C1DG24 Depth 129m



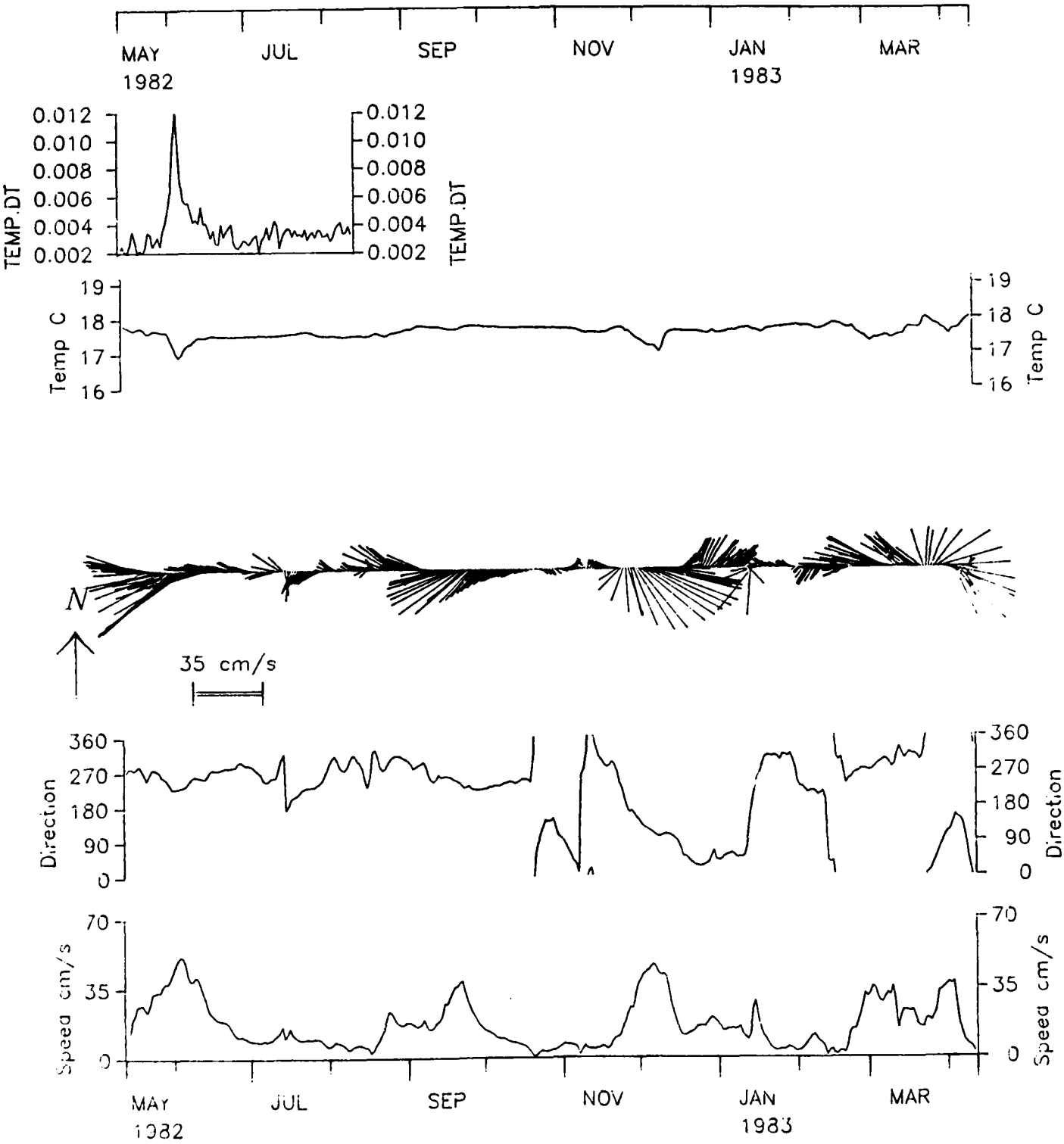
Data 7663C1DG24 Depth 178m



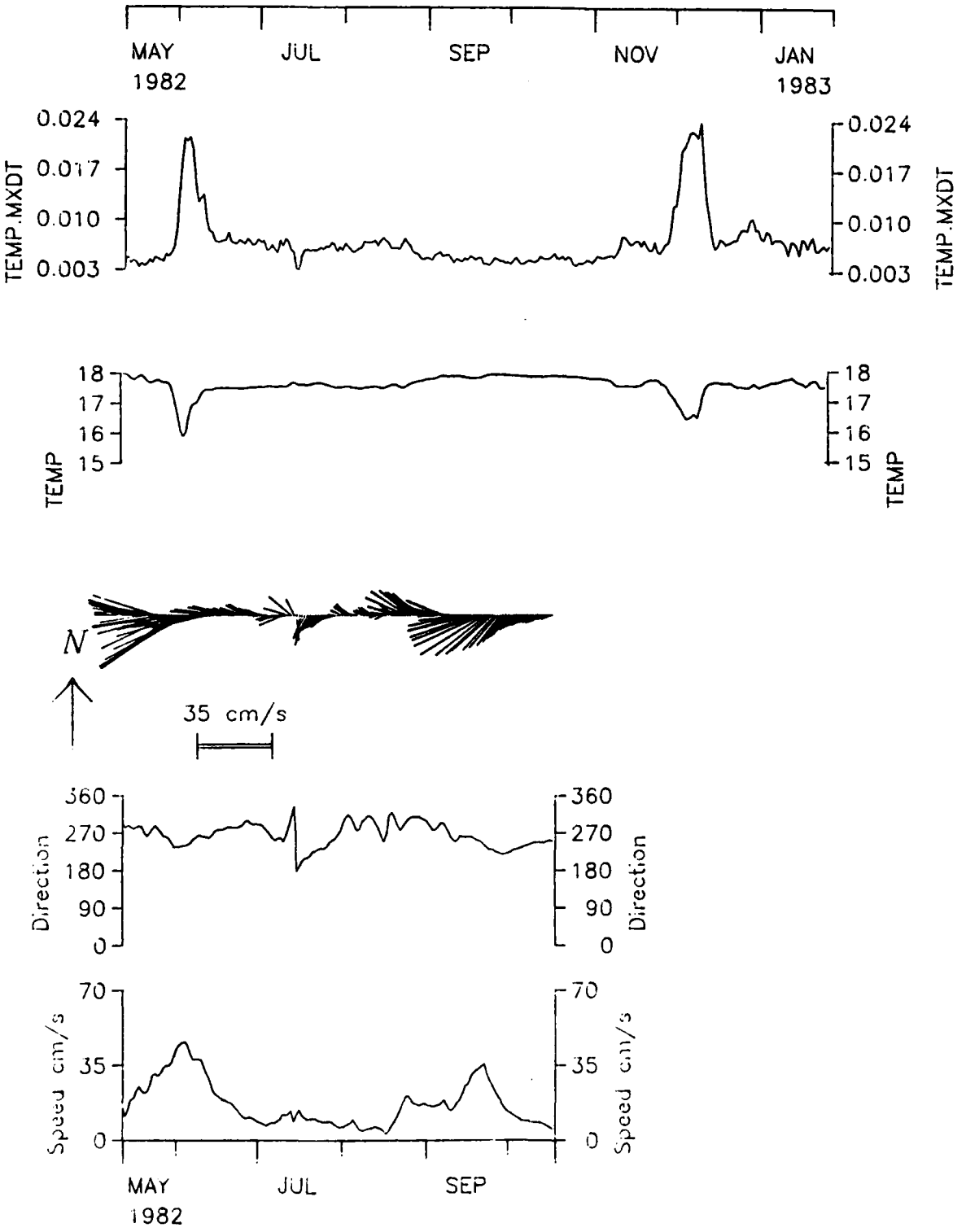
Data 7664C1DG24 Depth 228 m



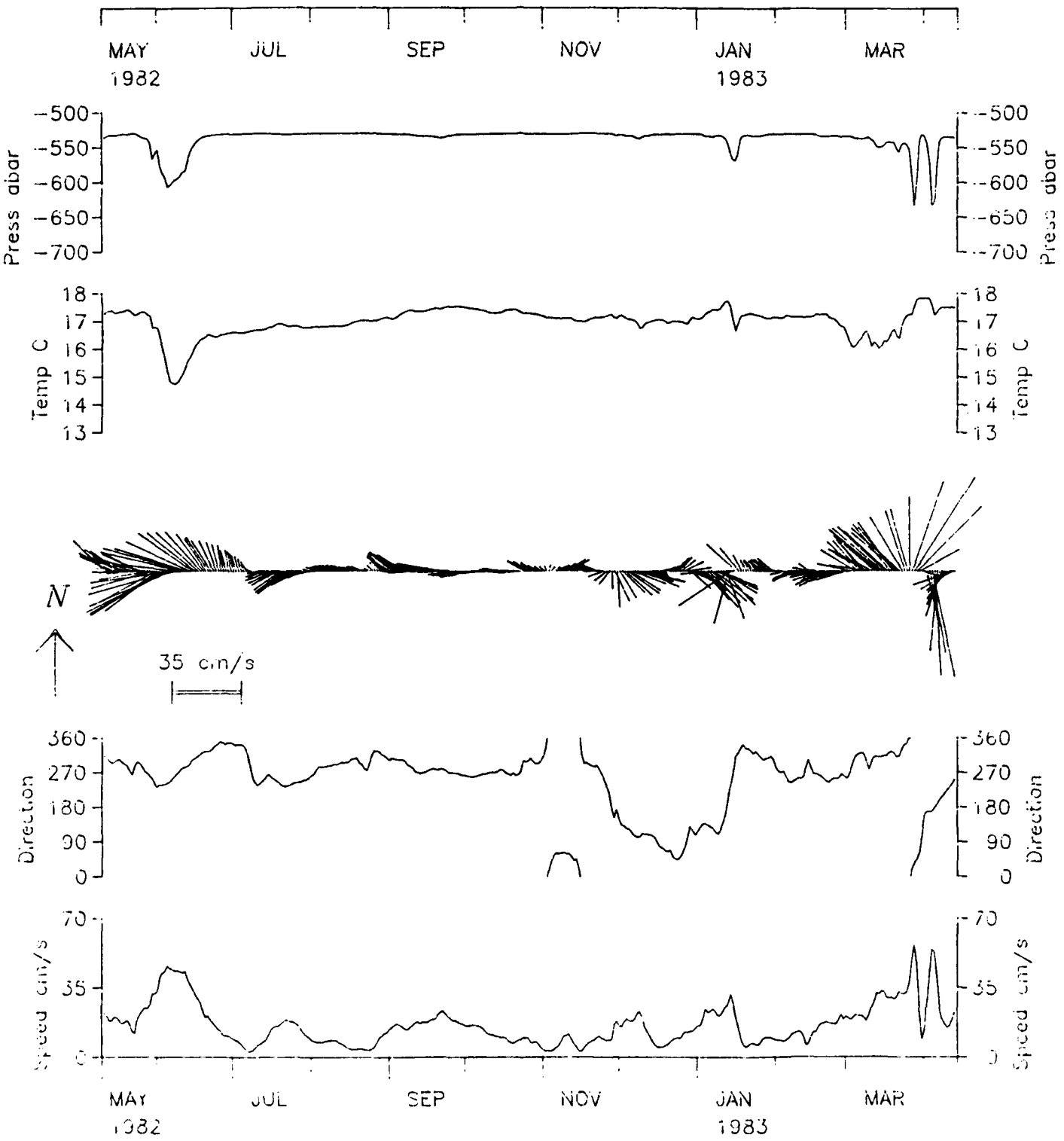
Data 7665C1DG24 Depth 278m



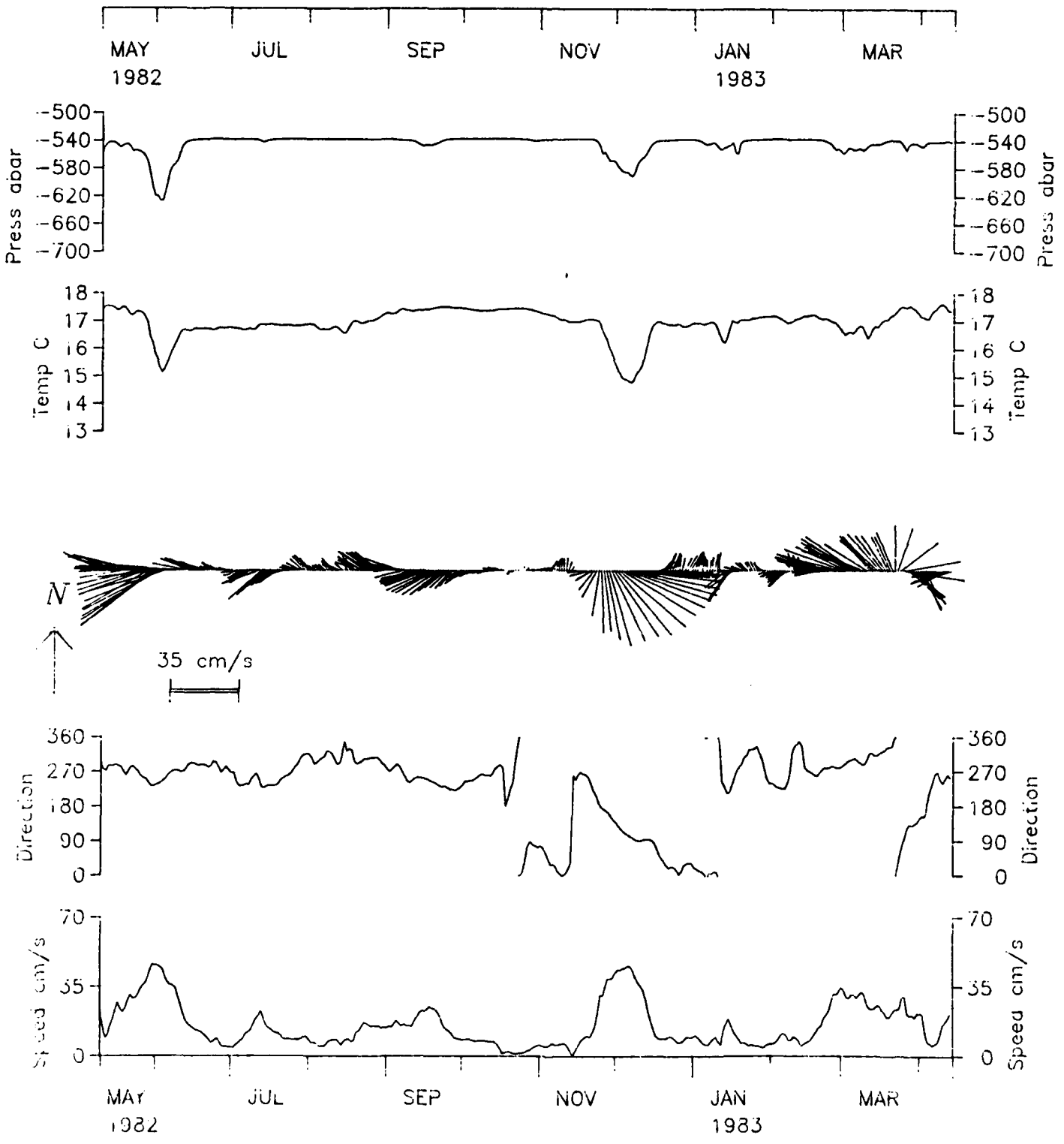
Data 7666C1DG24 Depth 328m



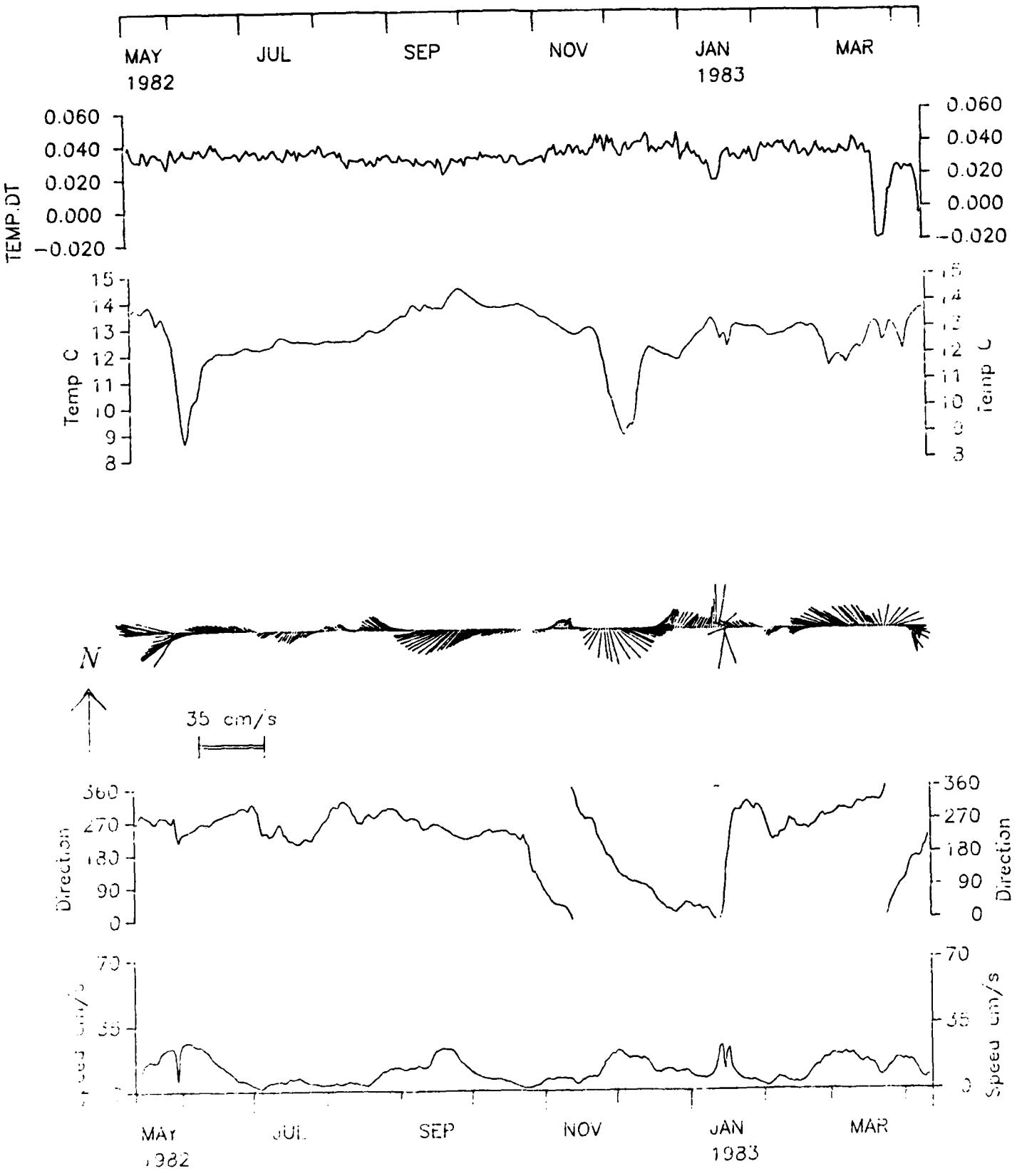
Data 7667C1DG24 Depth 427m

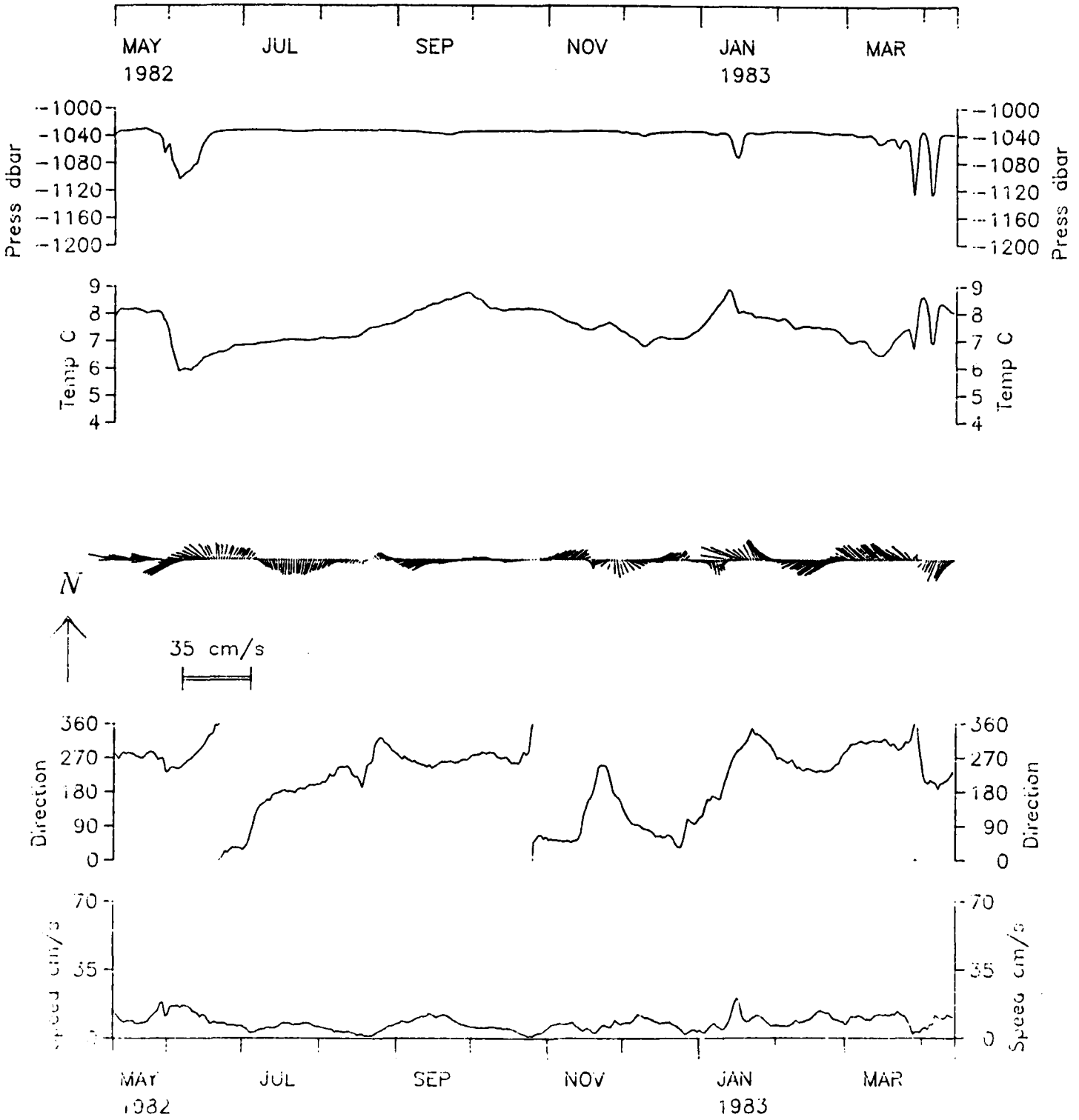


Data 7641C1DG24 Depth 527m

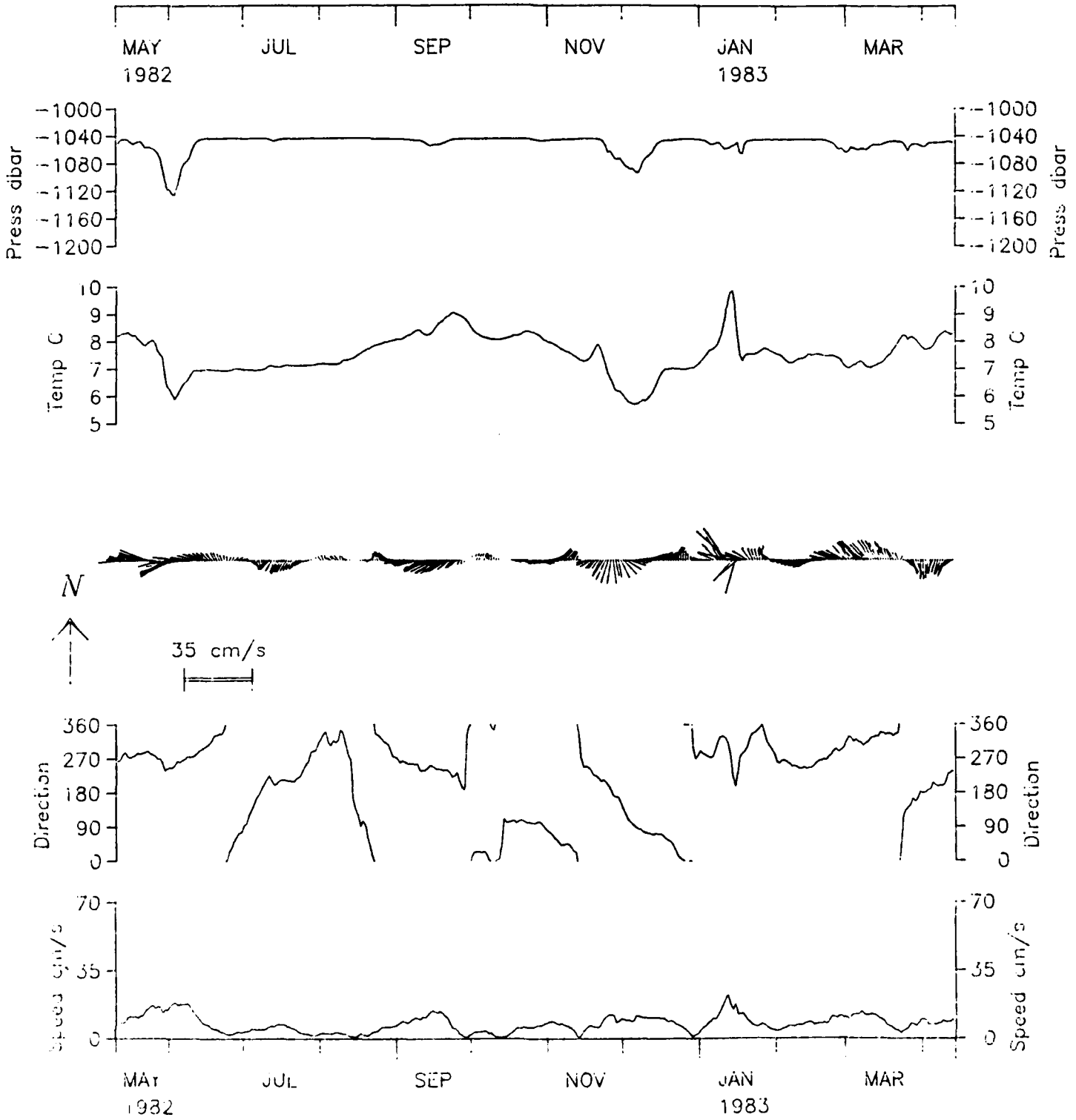


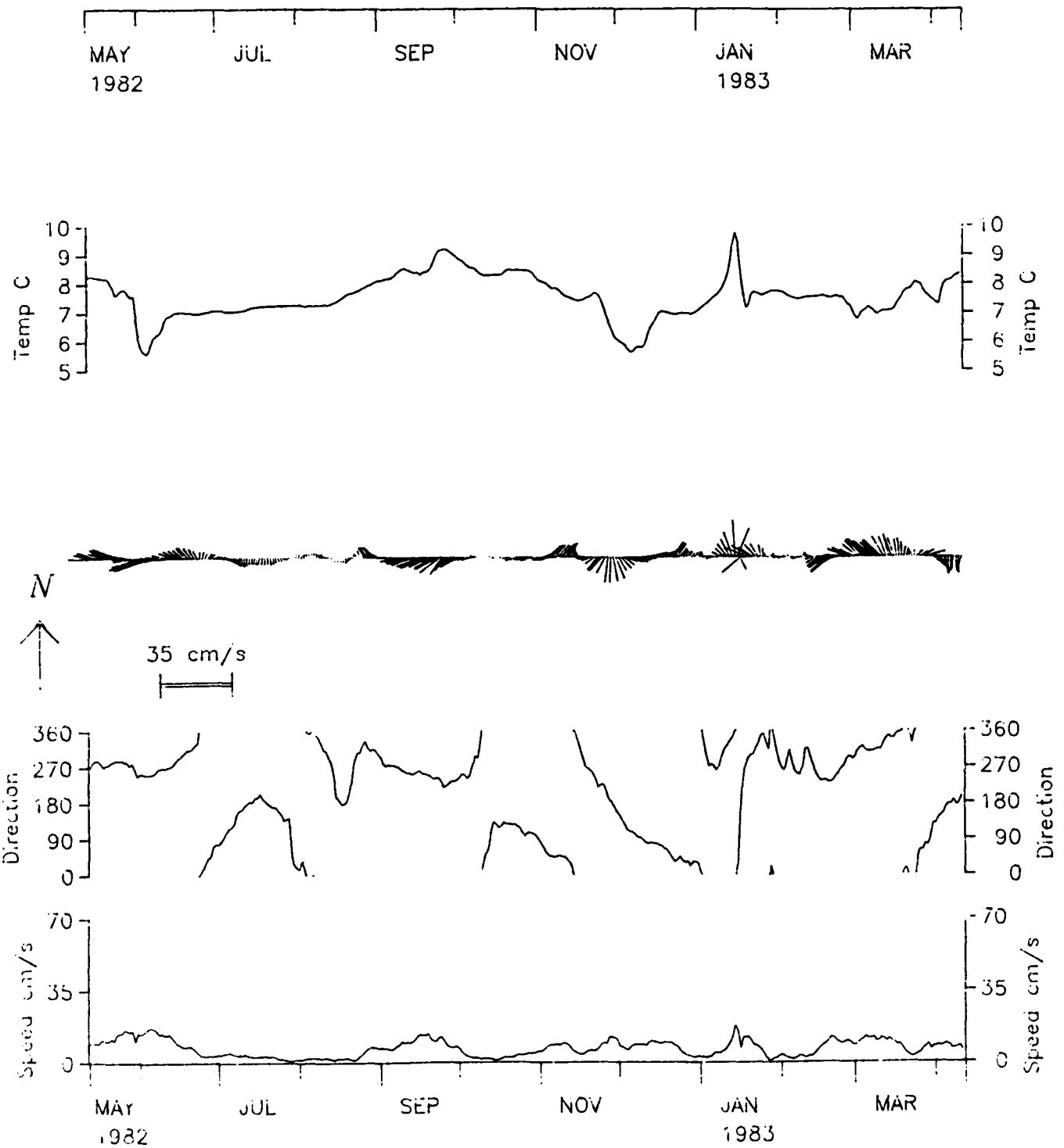
Data 7651C1DG24 Depth 527m


MAY
1982
JUL
SEP
NOV
JAN
1983
MAR
0.060
0.040
0.020
0.000
−0.020
TEMP.DT
Temp C
15
14
13
12
11
10
9
8
N
35 cm/s
Direction
360
270
180
90
0
70
35
0
Speed cm/s
Data 76611C1DG24
Depth 775m

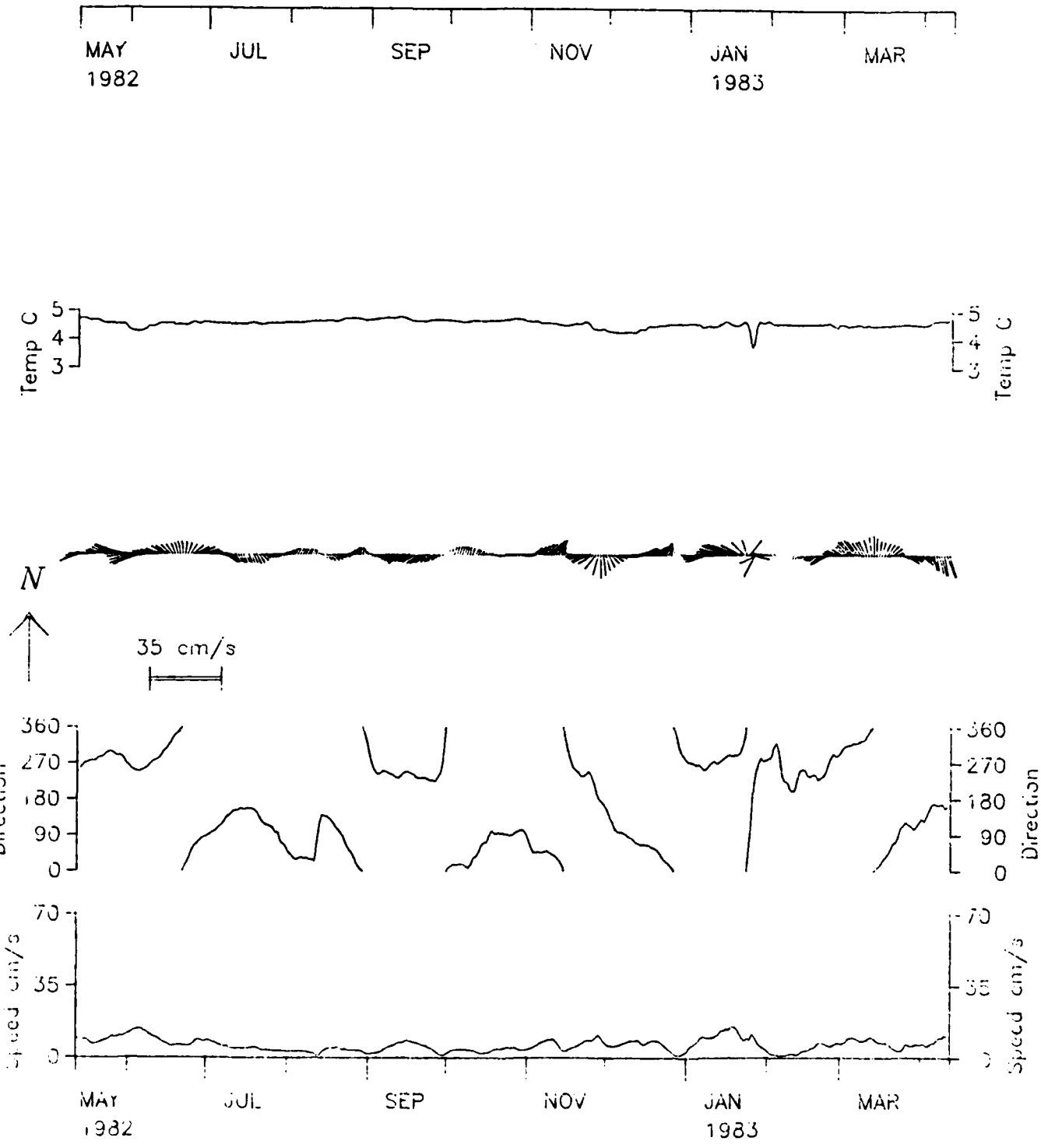


Data 7642C1DG24 Depth 1024m

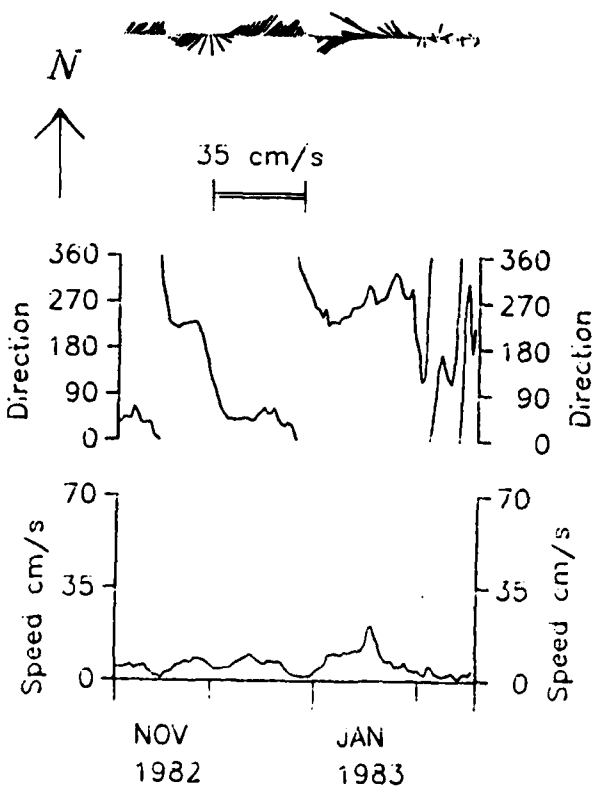

MAY
1982
JUL
SEP
NOV
JAN
1983
MAR
Press dbar
1000
1040
1080
1120
1160
1200
Temp C
10
9
8
7
6
5
N
35 cm/s
Direction
360
270
180
90
0
Speed cm/s
70
35
0
Data 7652C1DG24
Depth 1024m



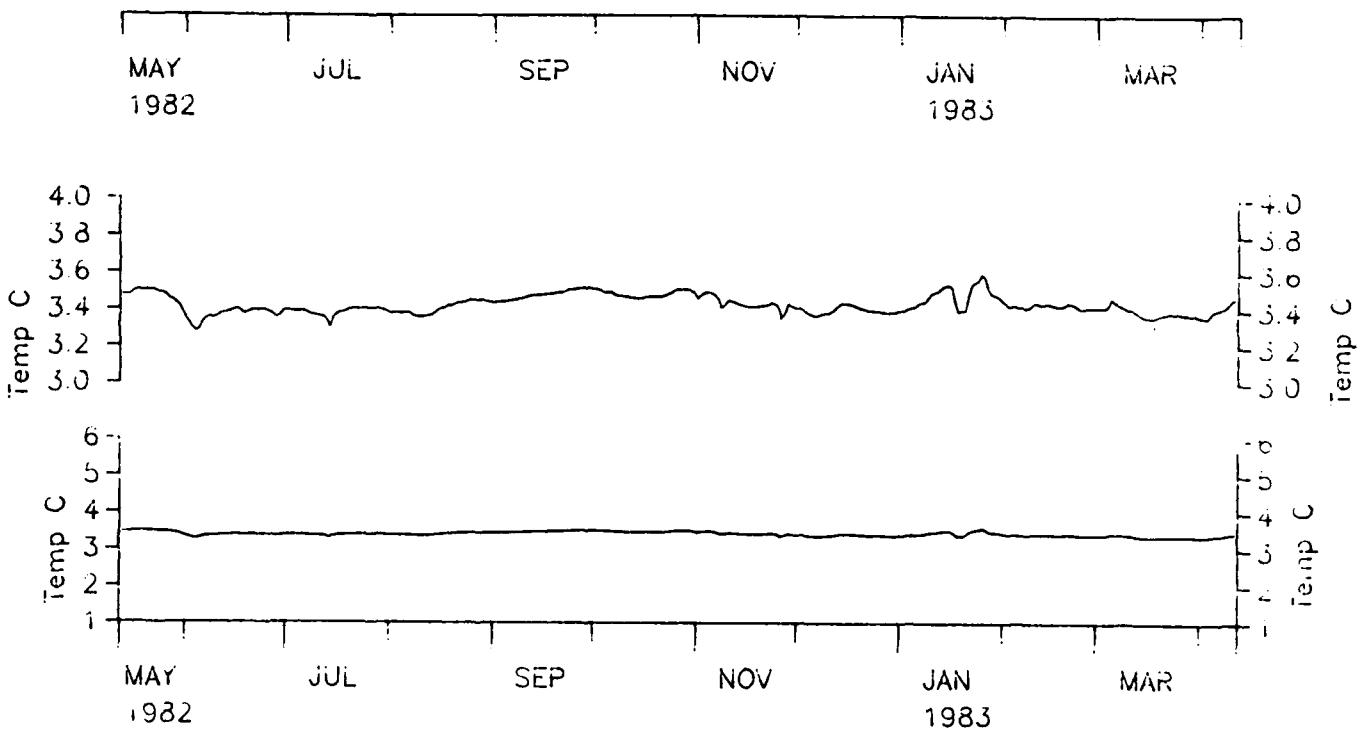
Data 76612C1DG24 Depth 1024m



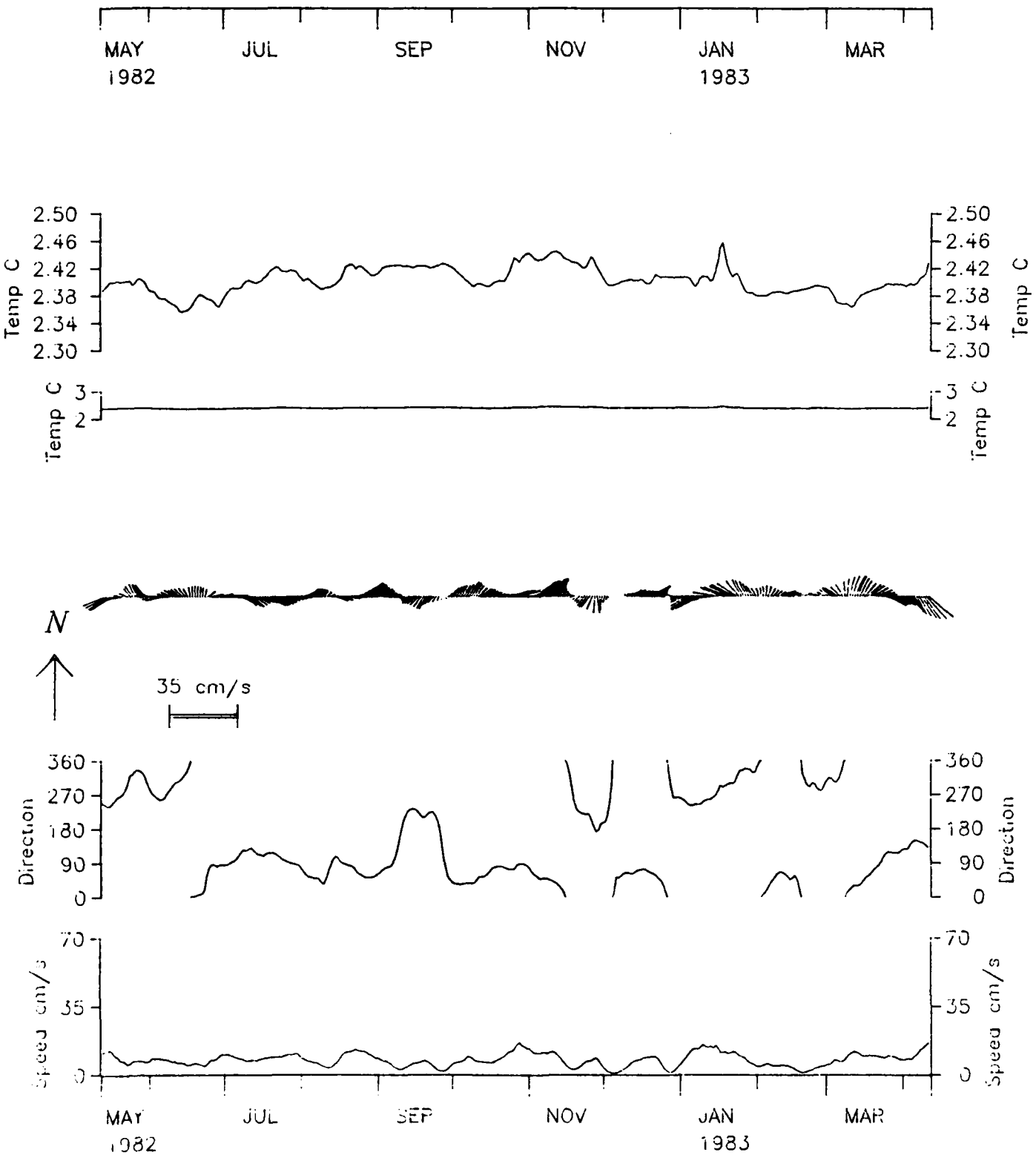
Data 76613C1DG24 Depth 1521m



Data 77014C1DG24 Depth 2500m

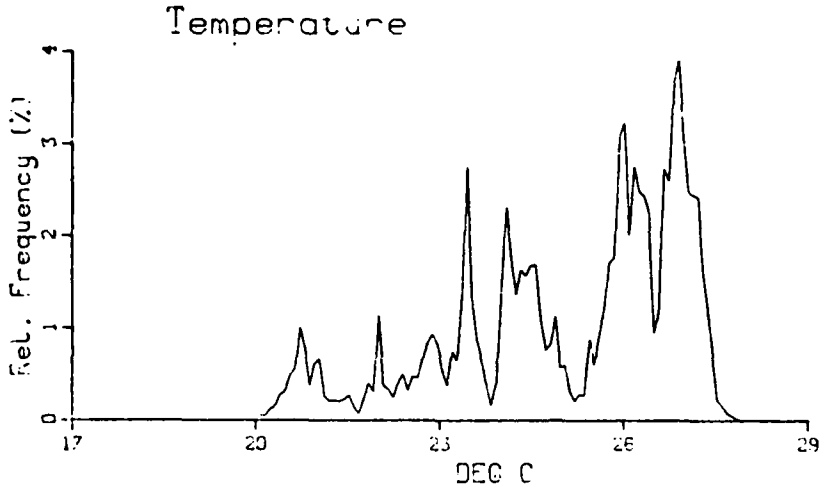


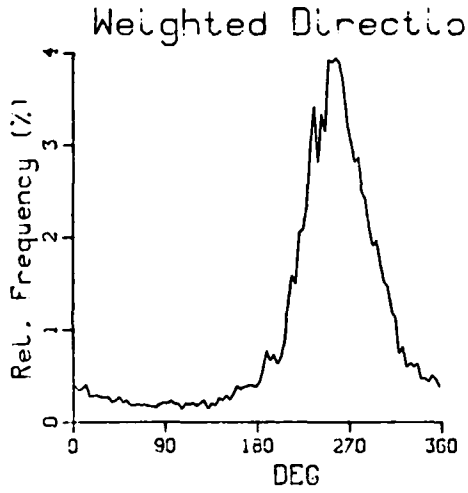
Data 76614C1DG24 Depth 2516m

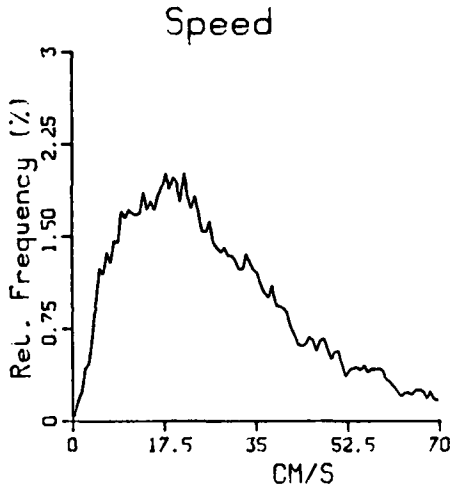


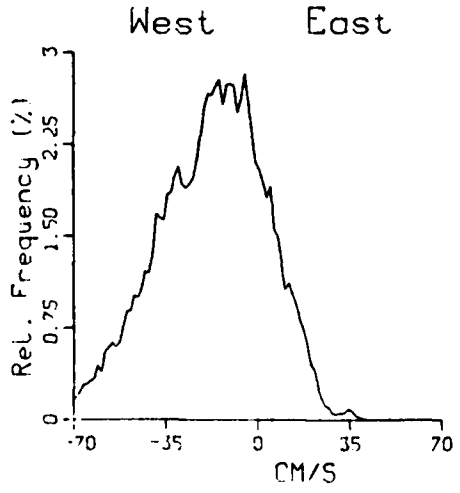
Data 76615C1DG24 Depth 4007m

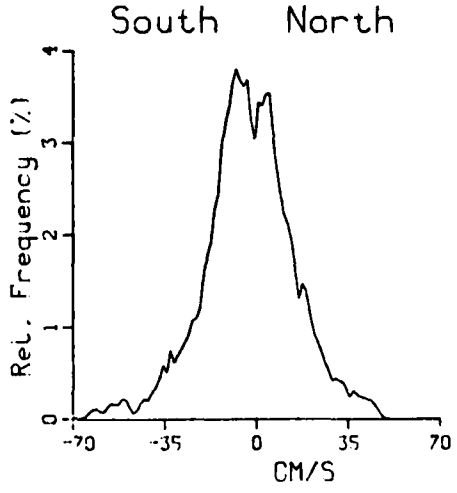
HISTOGRAMS



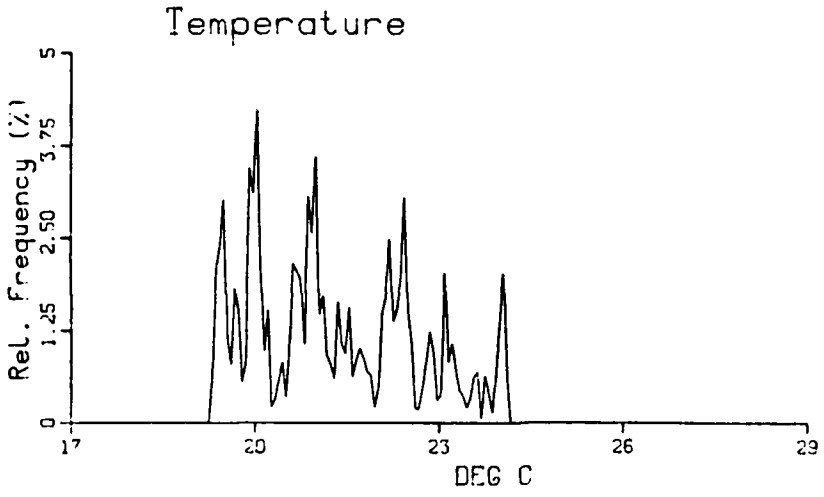


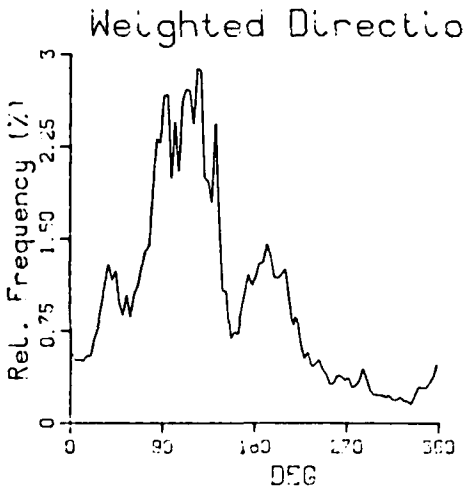


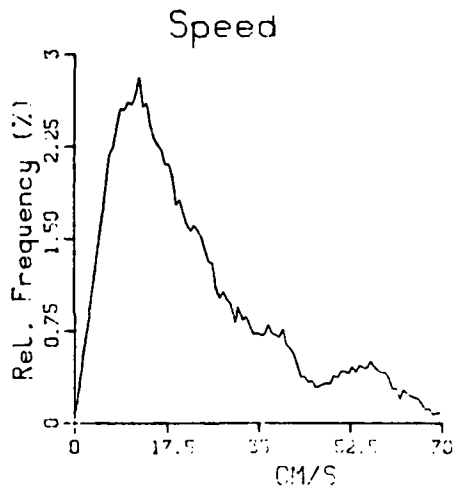


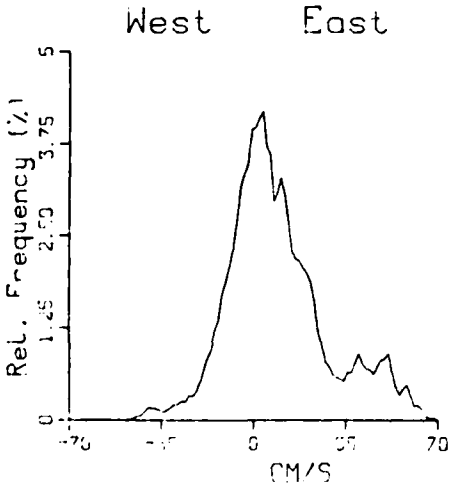


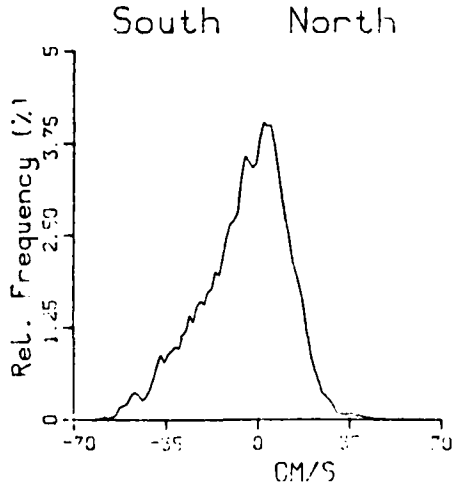
Data File 7673E225 : Depth = 5m



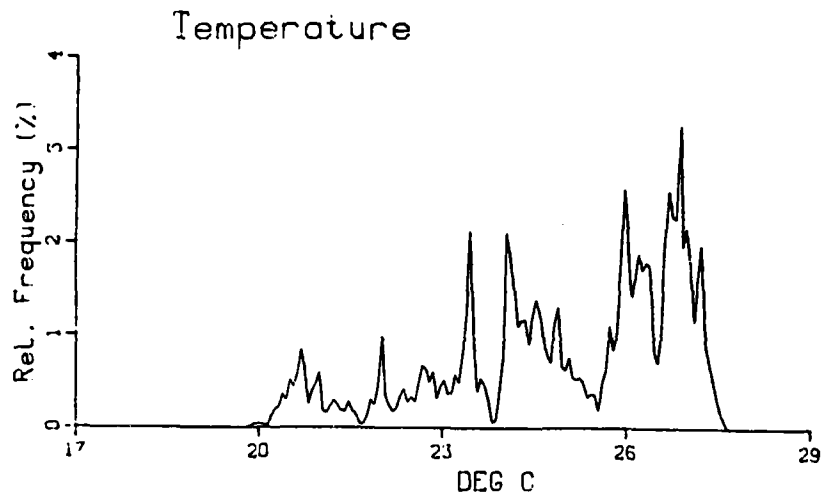


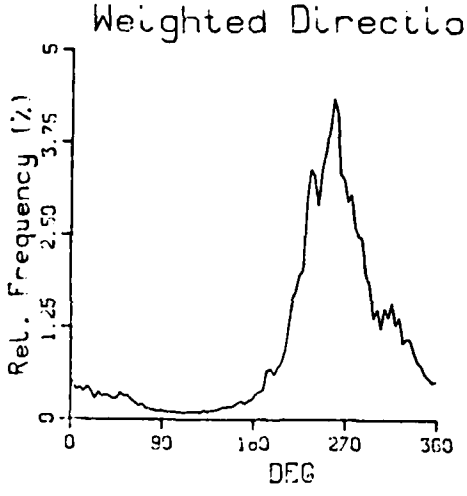


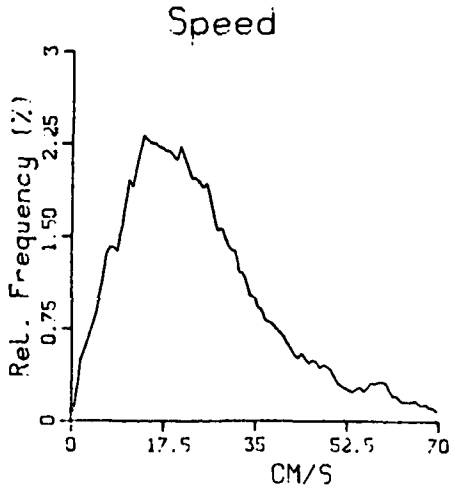


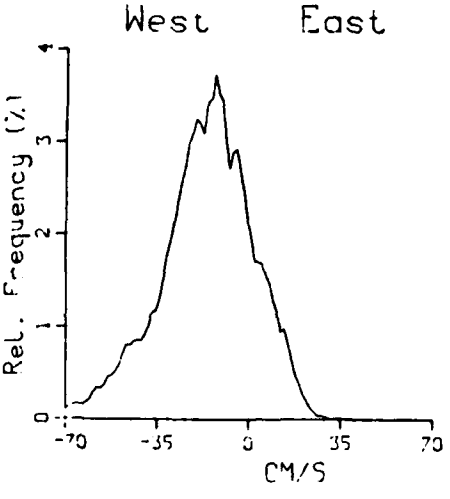


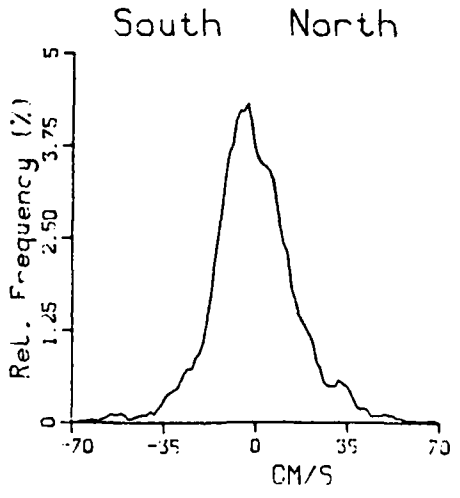
Data File 77030225 · Depth = 5m



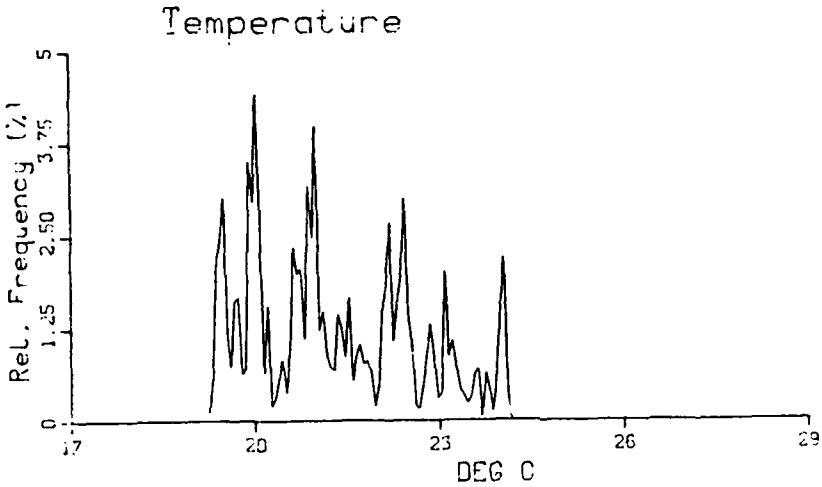


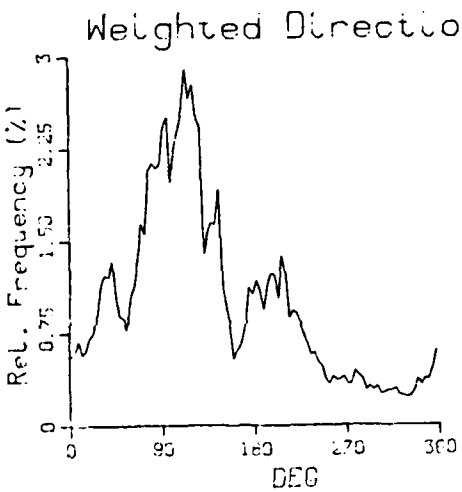


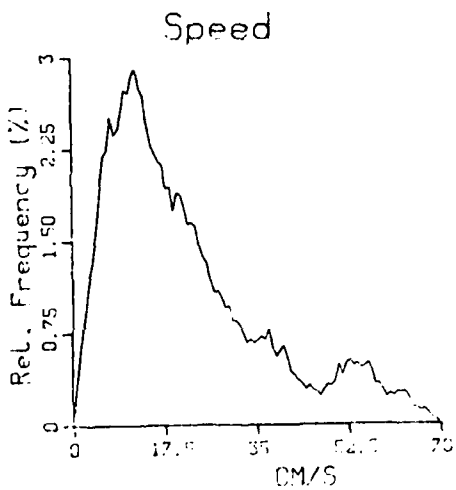


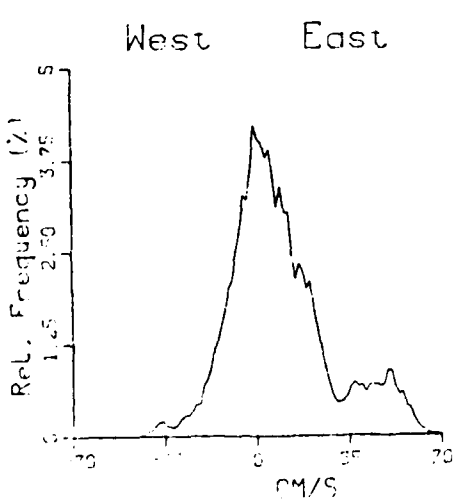


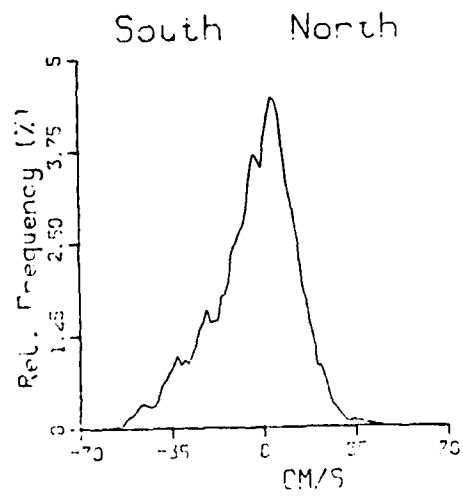
Data File 7674C225 : Depth = 10m











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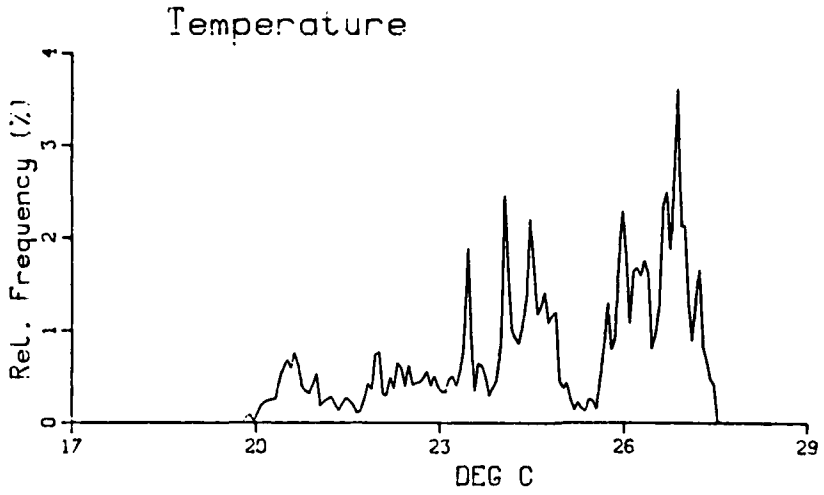

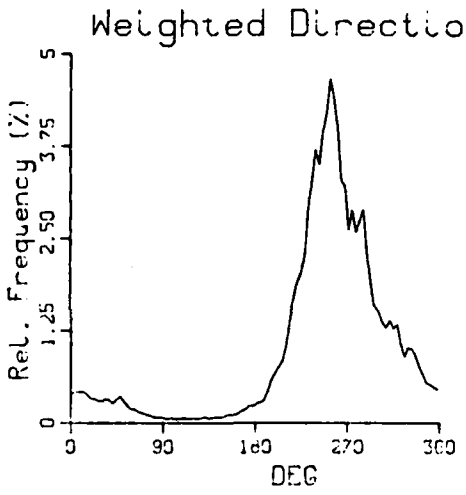

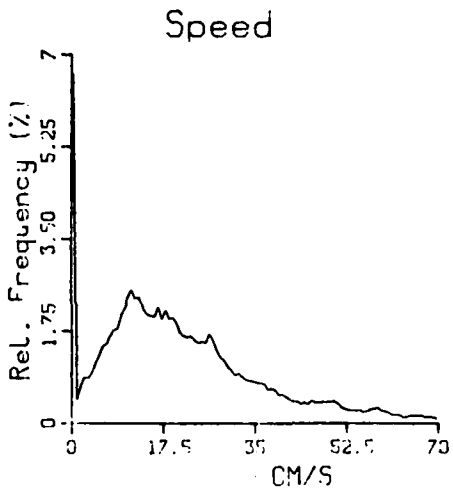

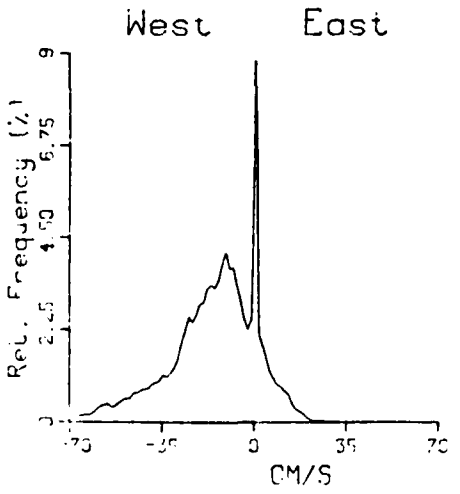

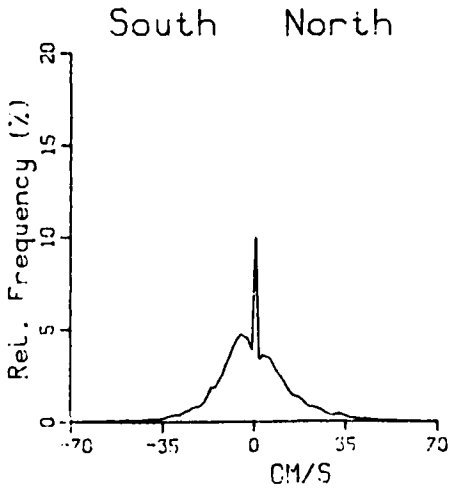

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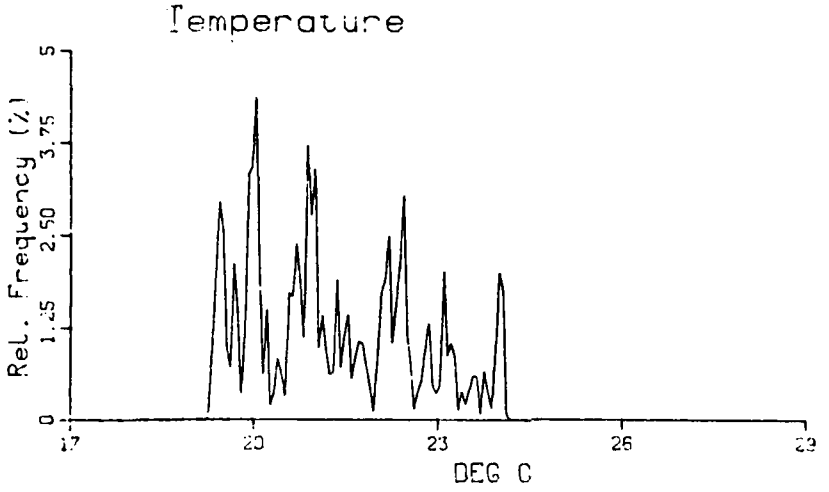

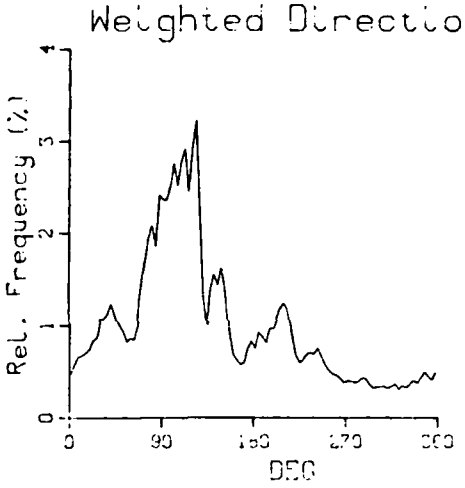

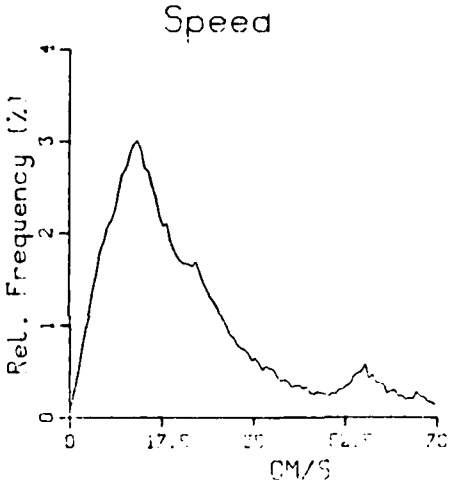

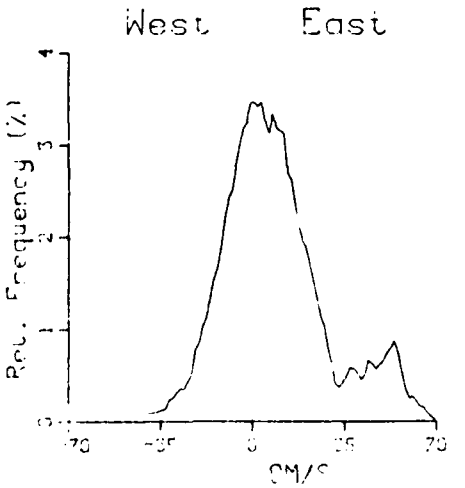

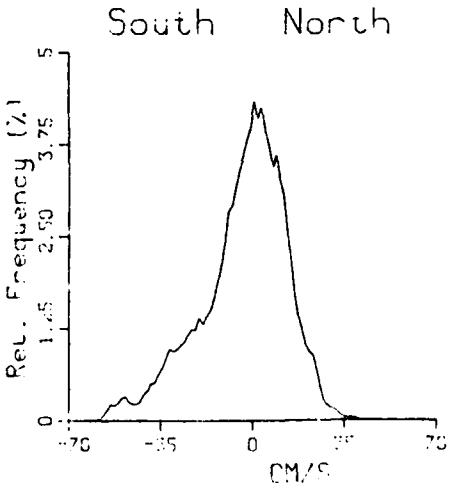

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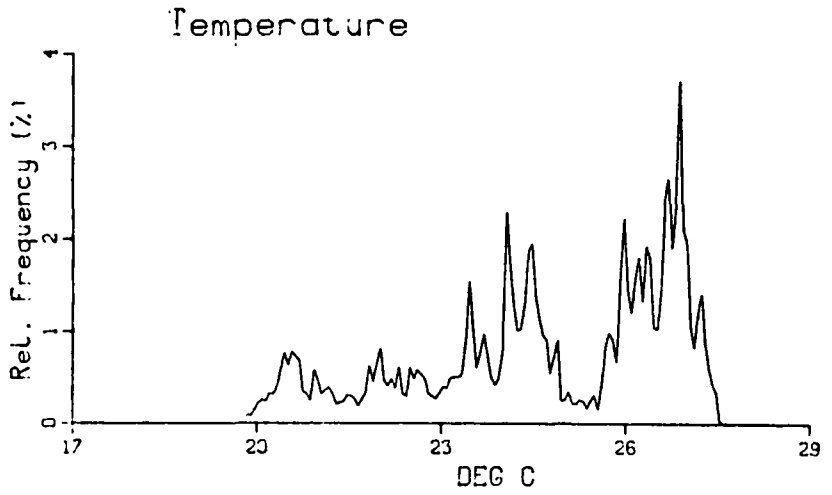

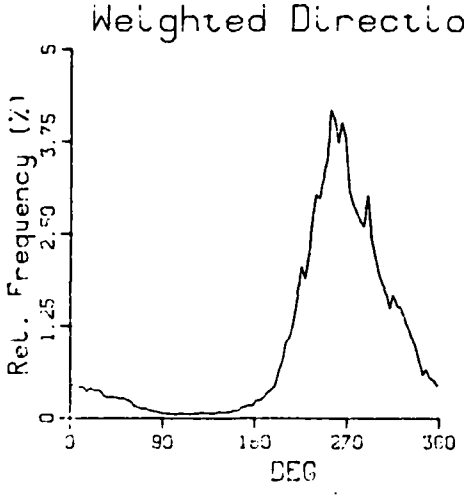

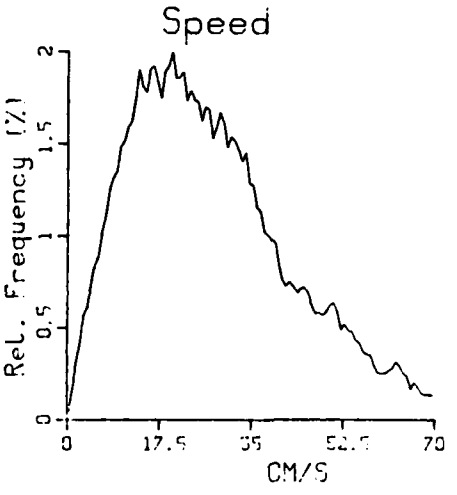

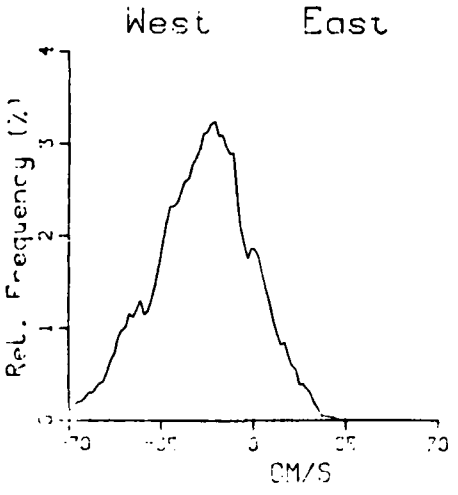

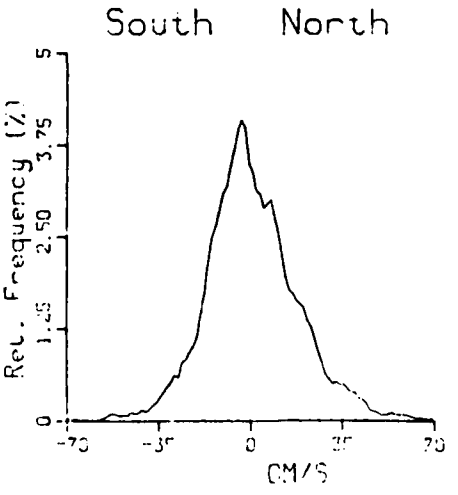

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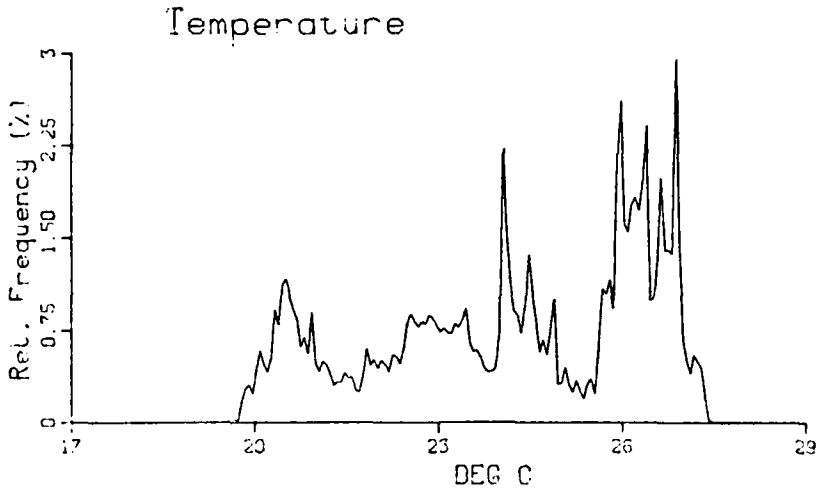

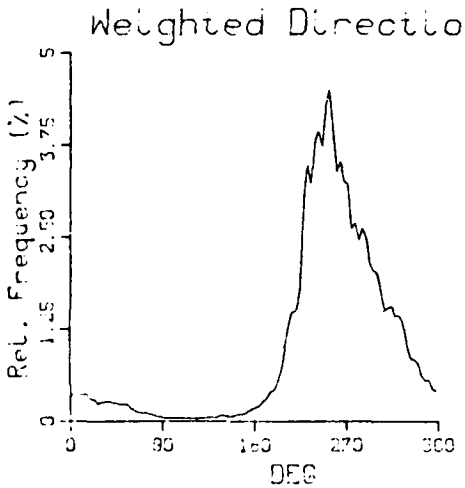

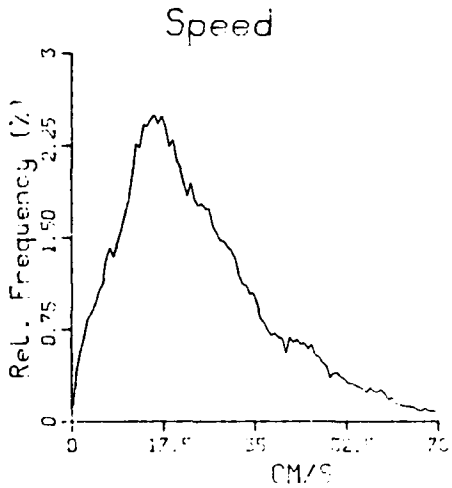

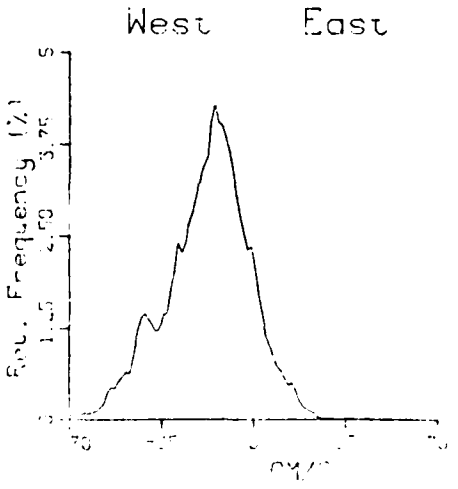

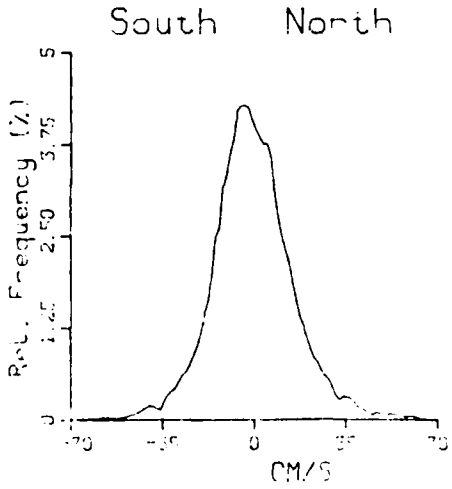

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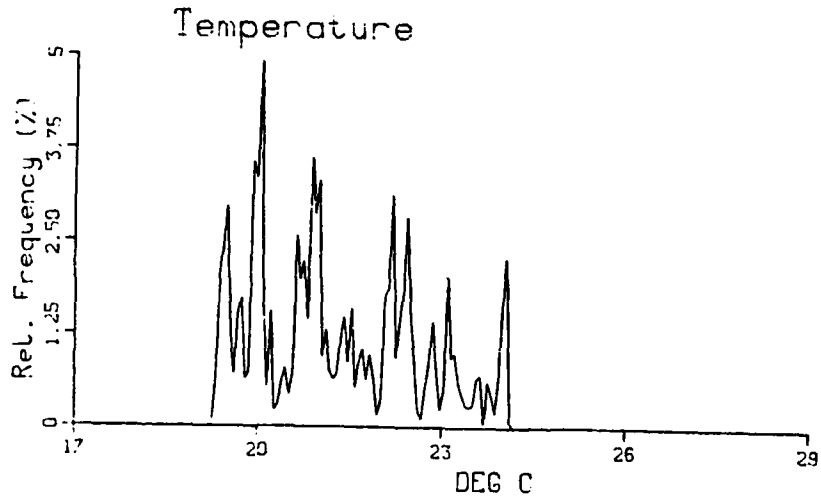

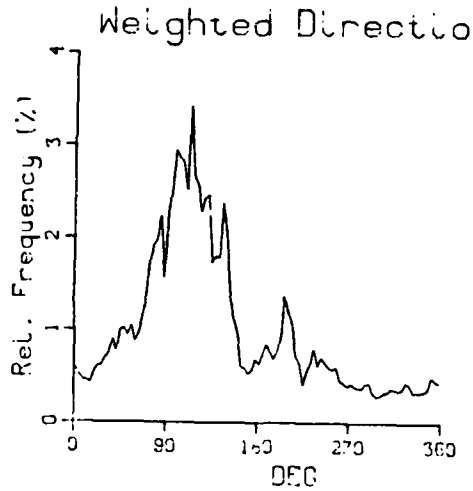

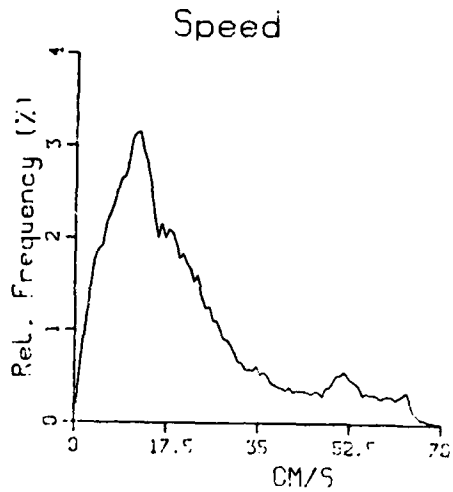

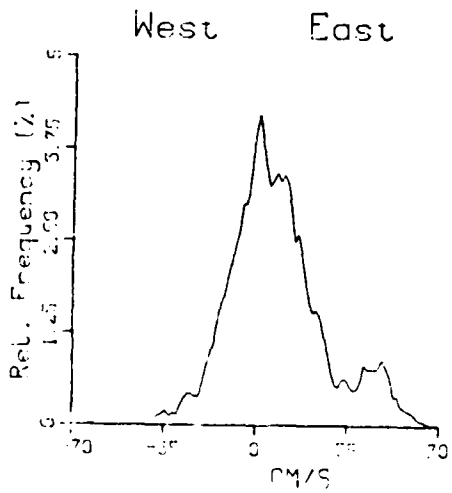

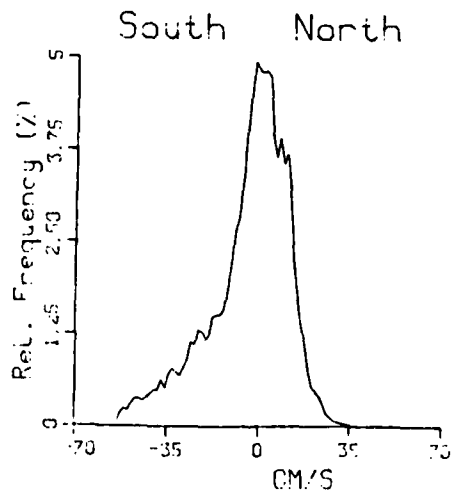

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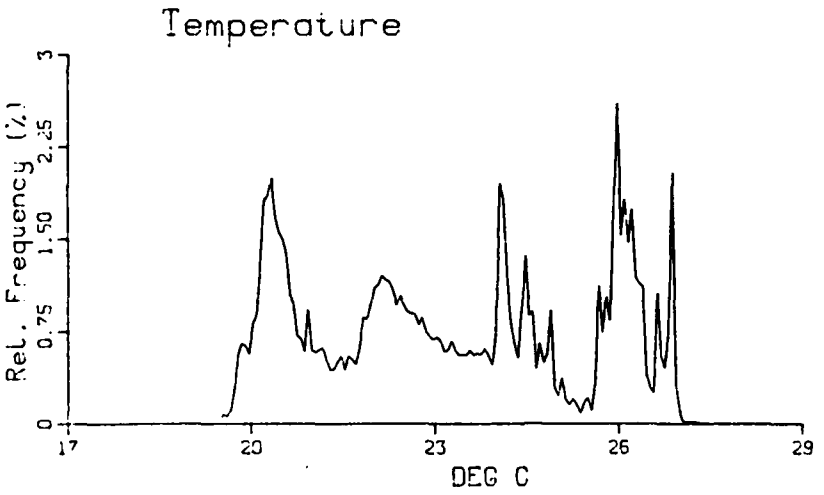

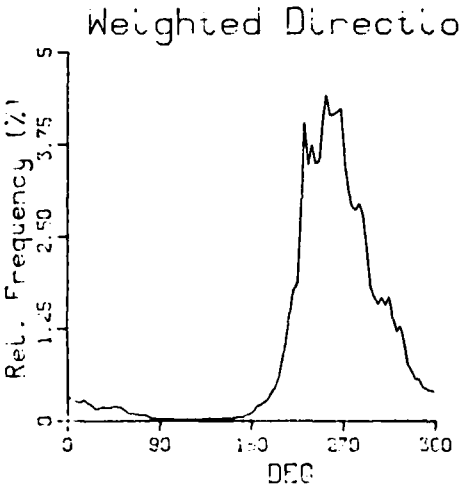

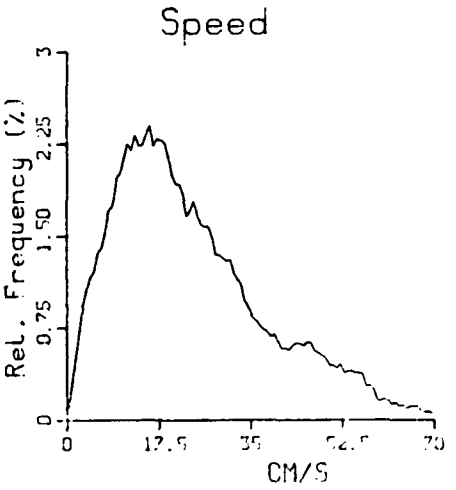

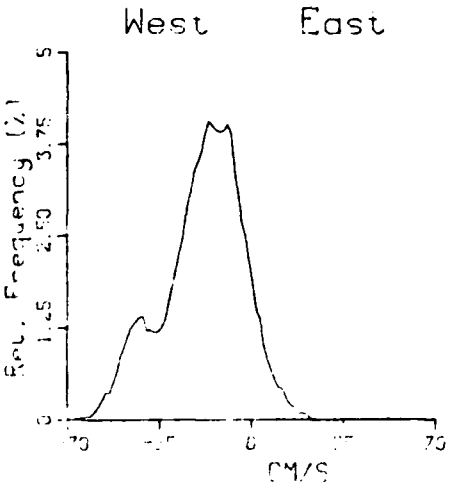

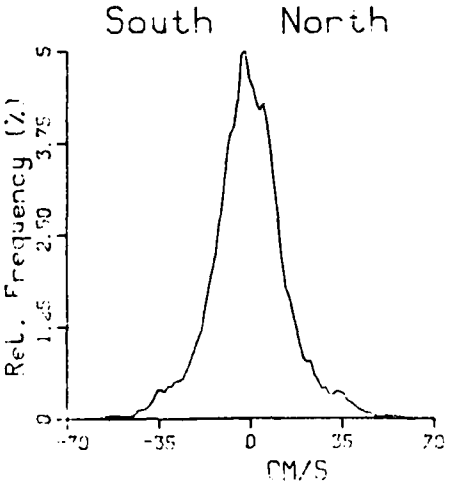

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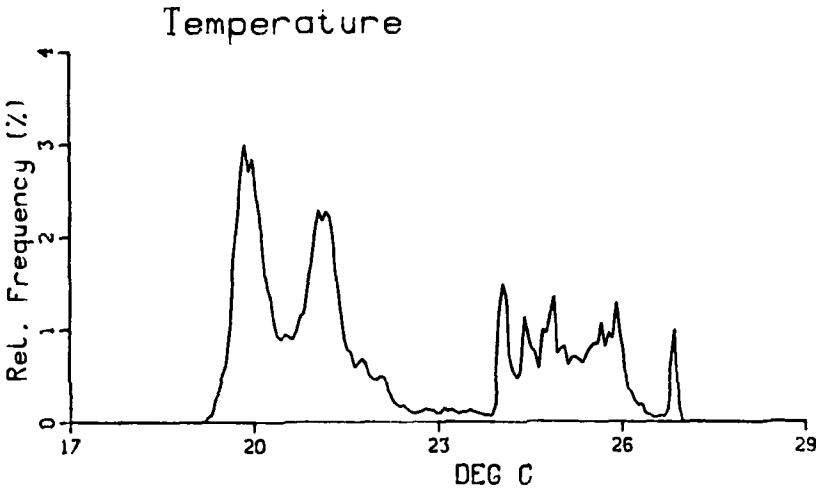

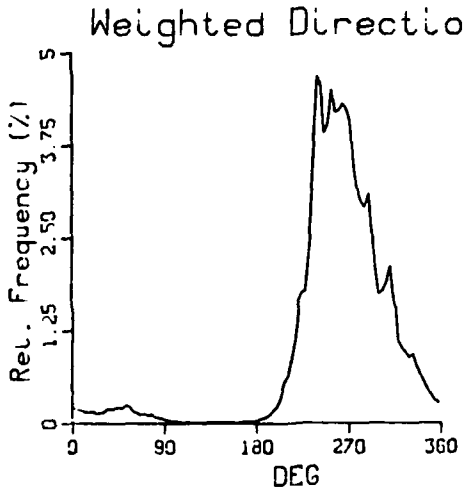

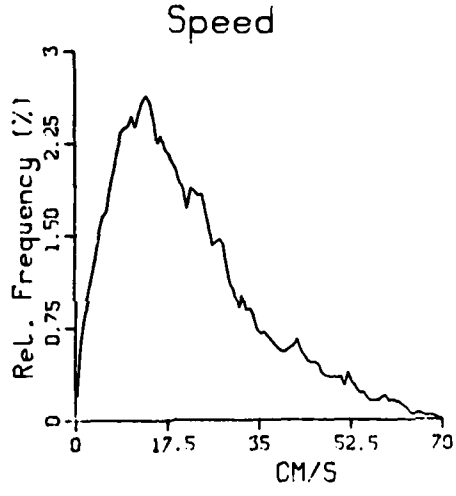

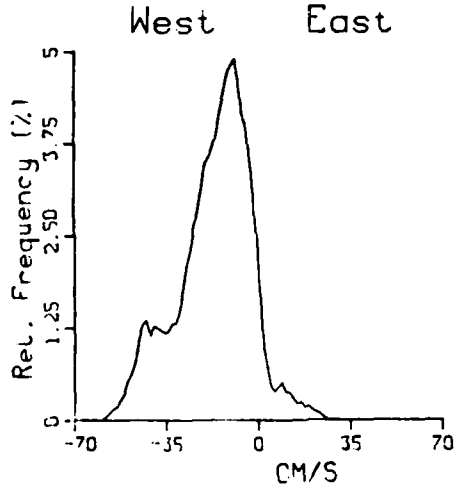

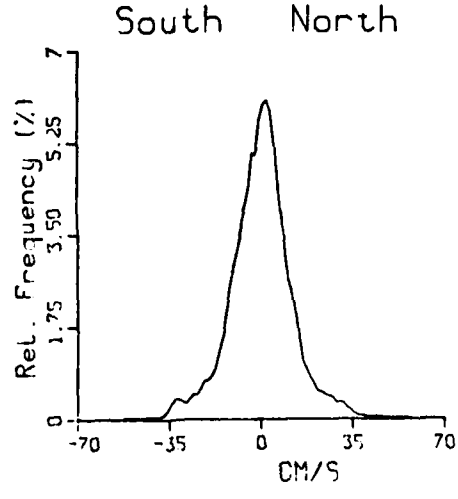

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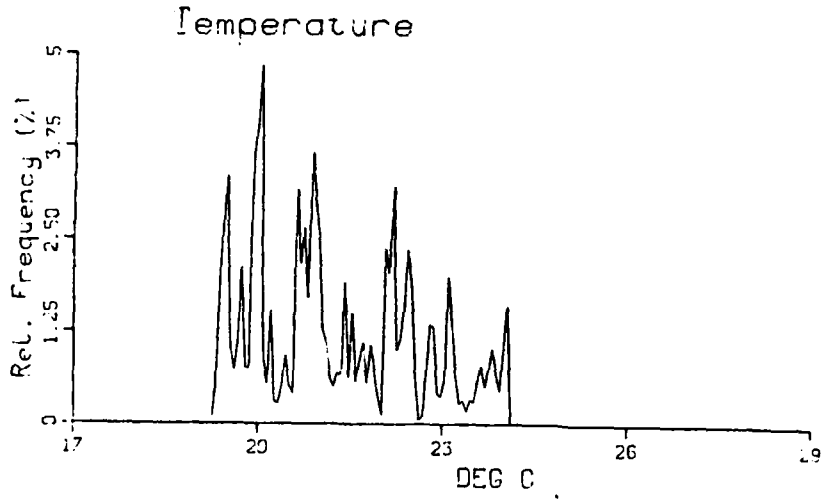

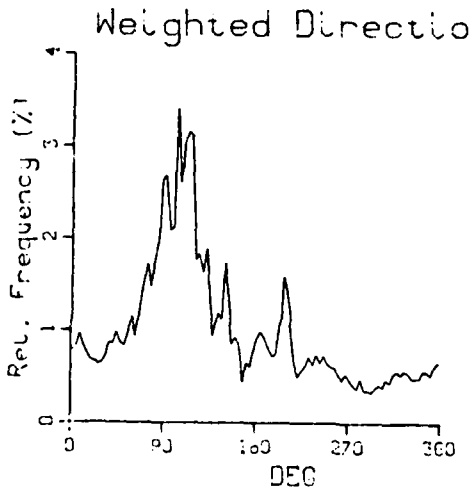

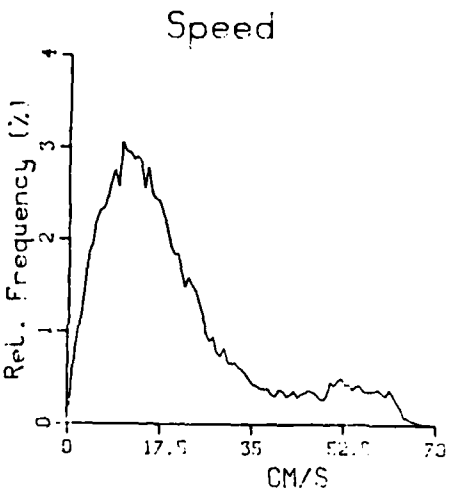

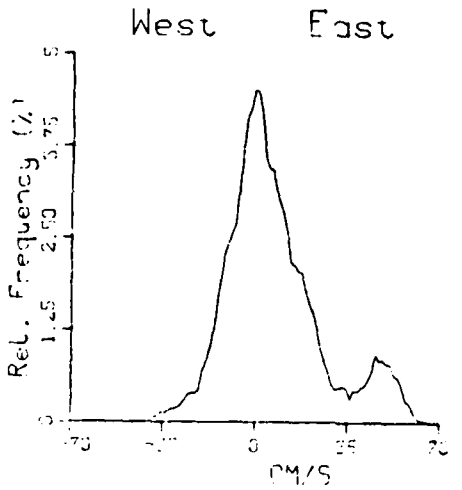

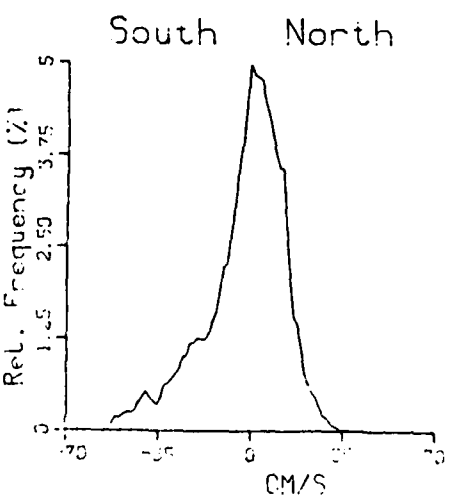

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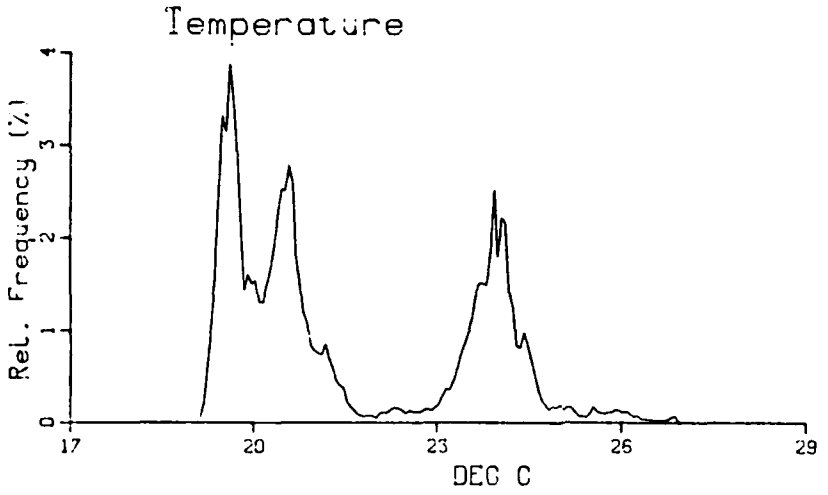

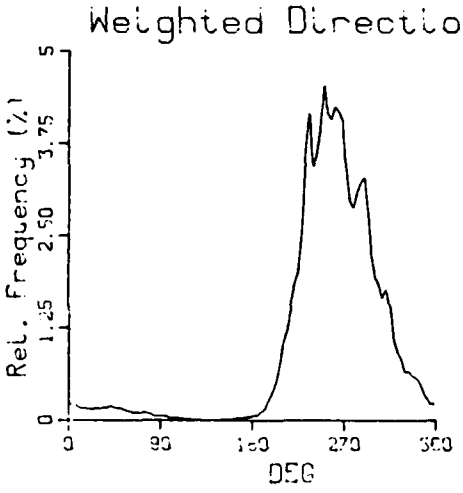

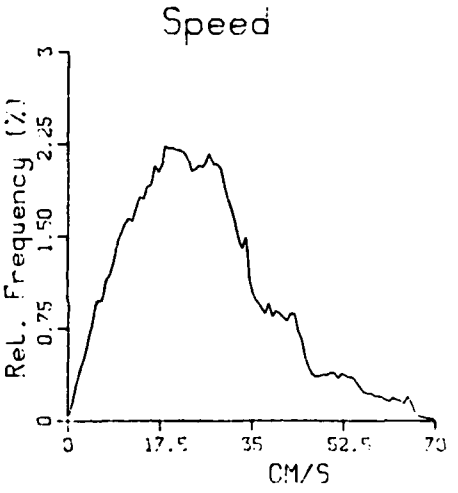

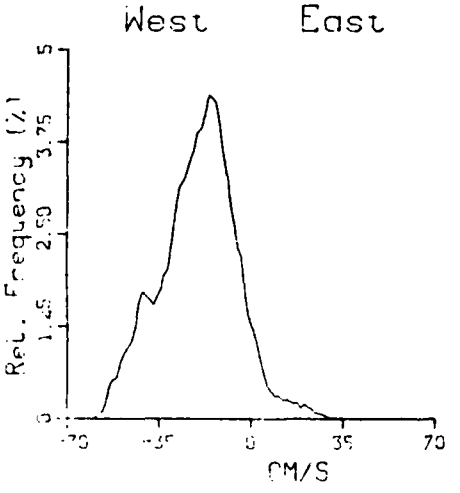

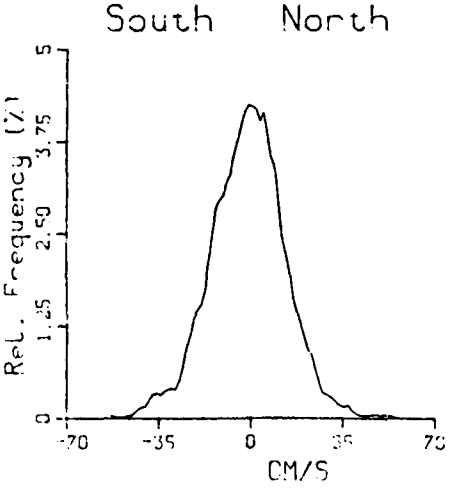

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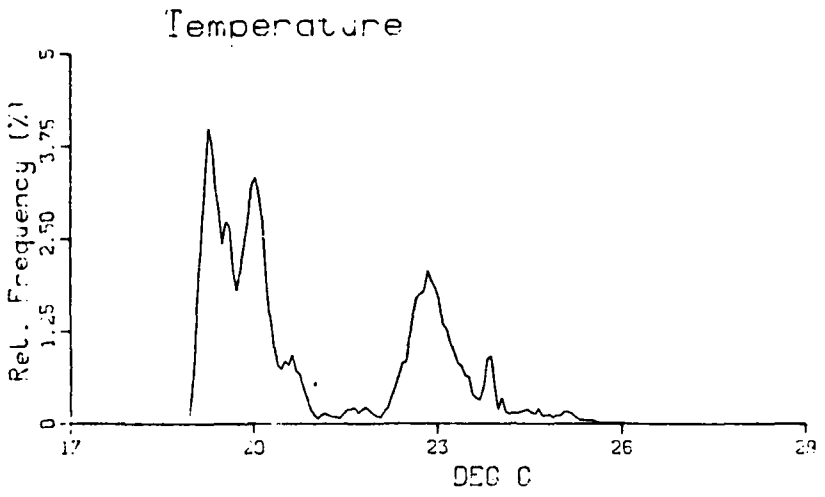

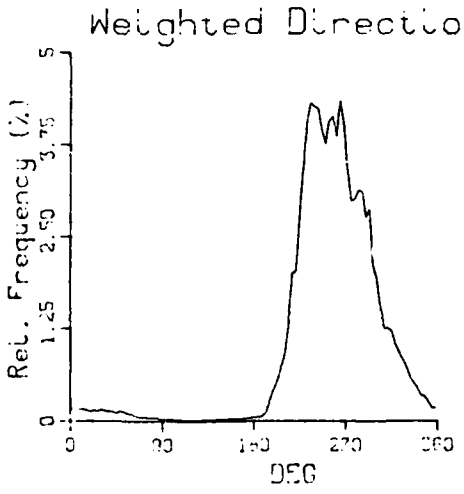

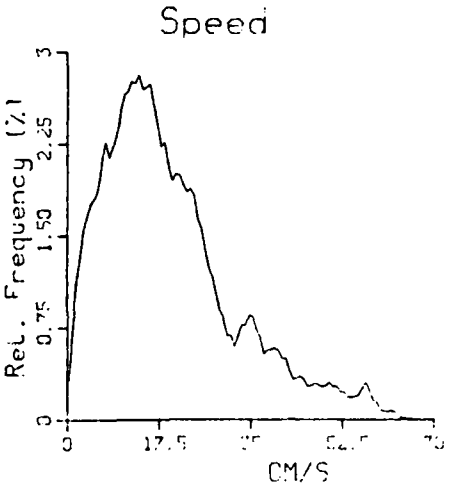

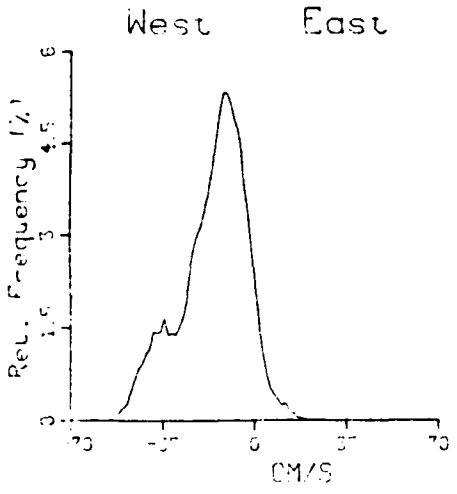

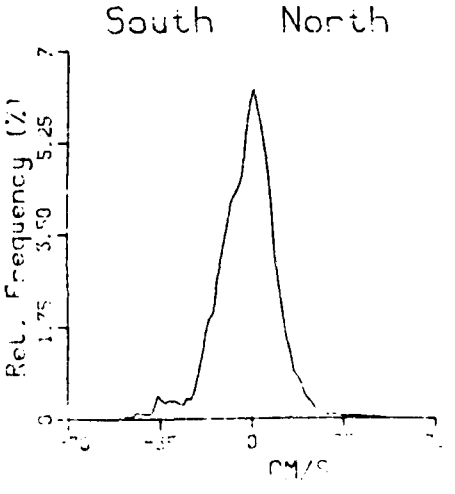

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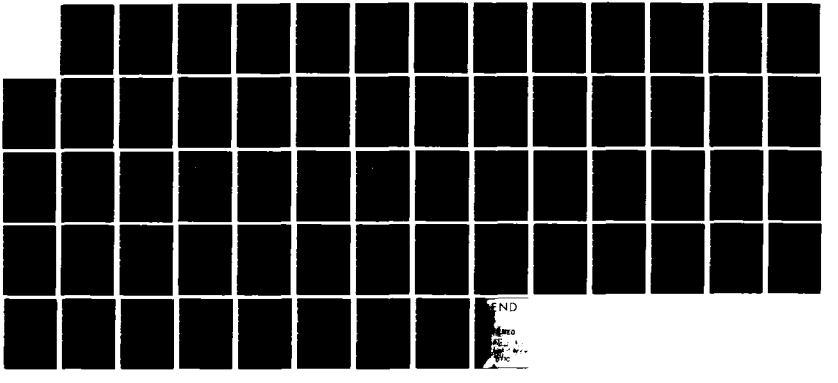
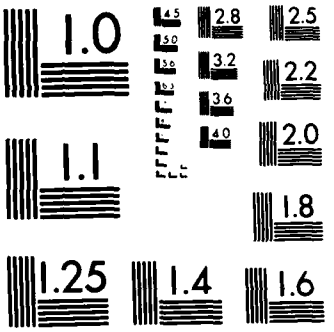
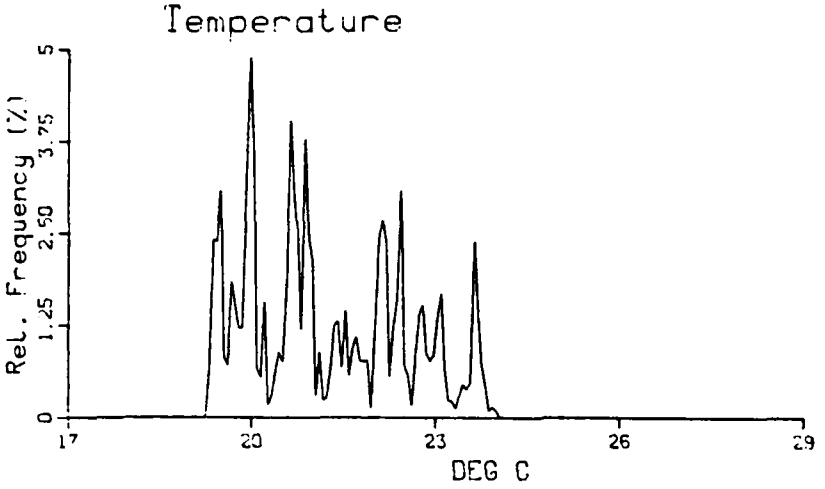
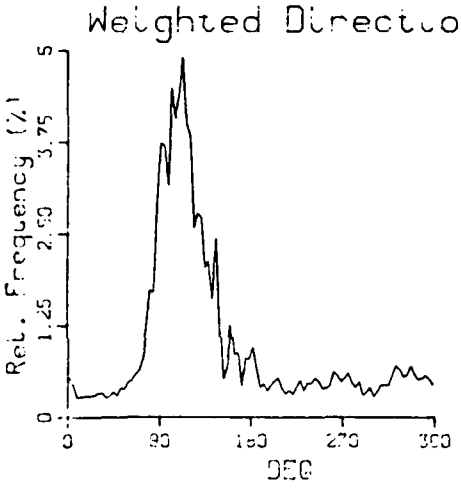
AD-A147 103 A COMPILATION OF MOORED CURRENT METER AND WIND RECORDER DATA VOLUME 35 LO..(U) WOODS HOLE OCEANOGRAPHIC INSTITUTION MA S A TARBELL ET AL. AUG 84 WHOI-84-36 2/2

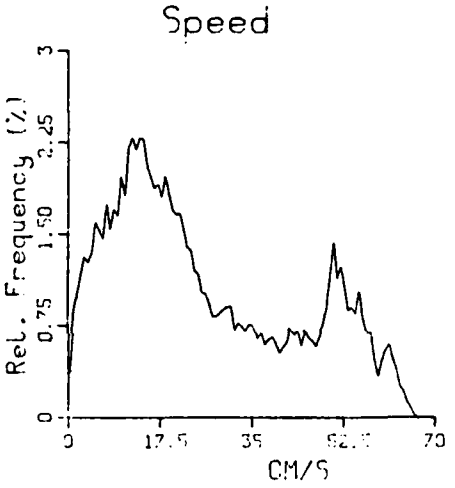
UNCLASSIFIED N00014-76-C-0197 F/G 8/3 NL

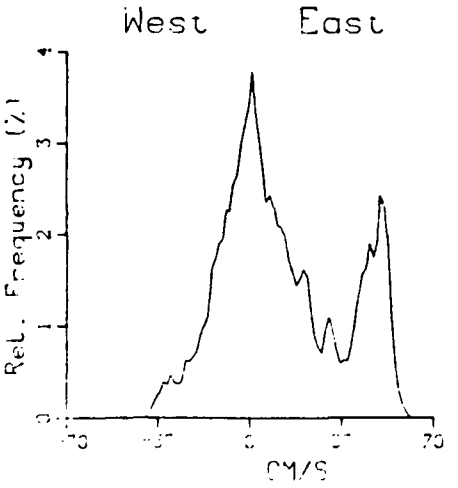


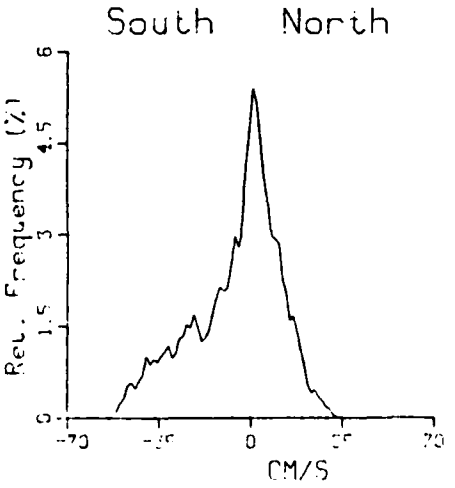












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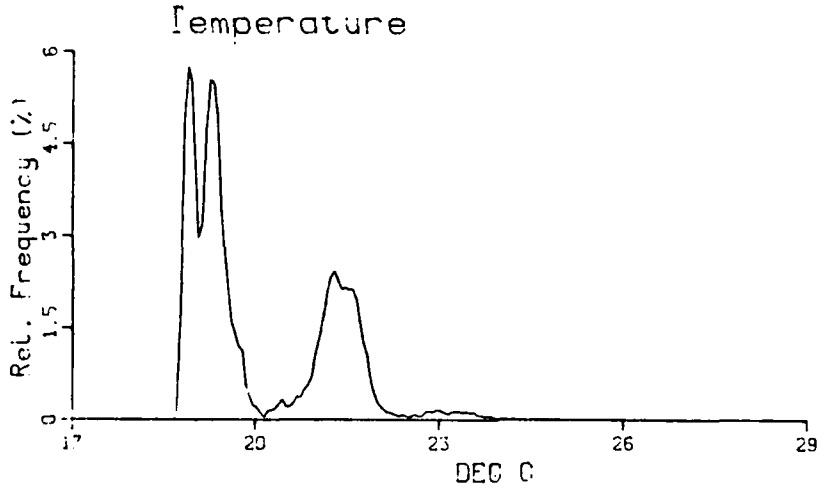

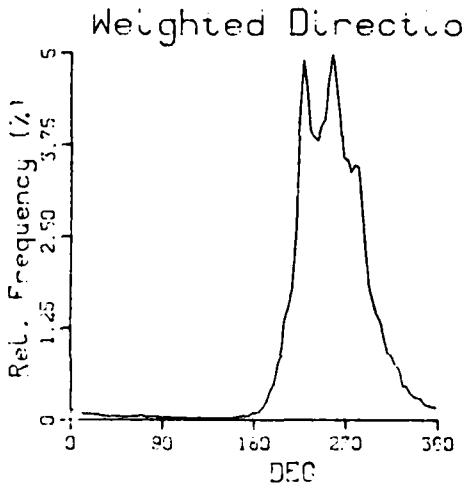

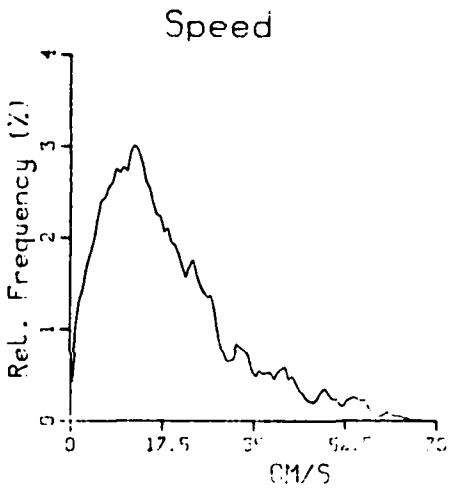

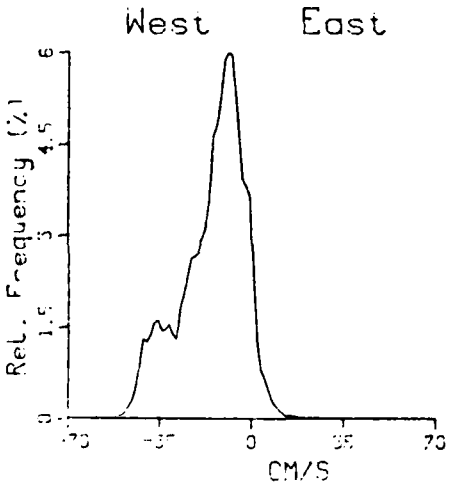

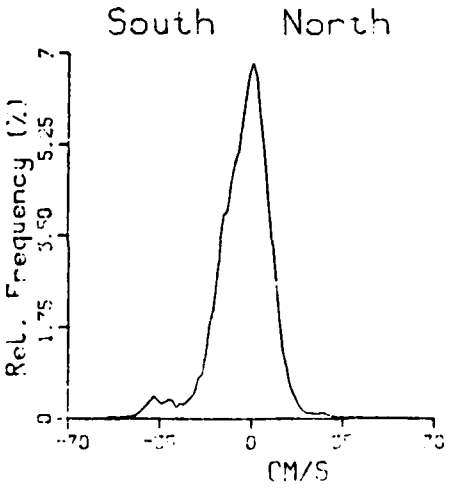

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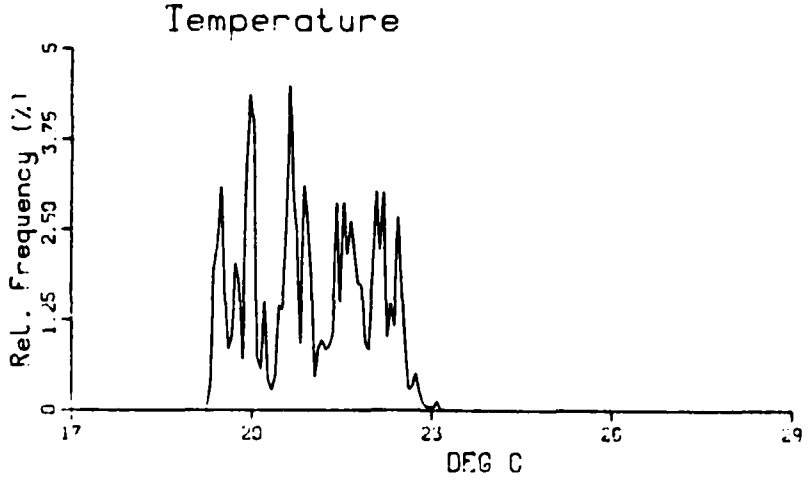

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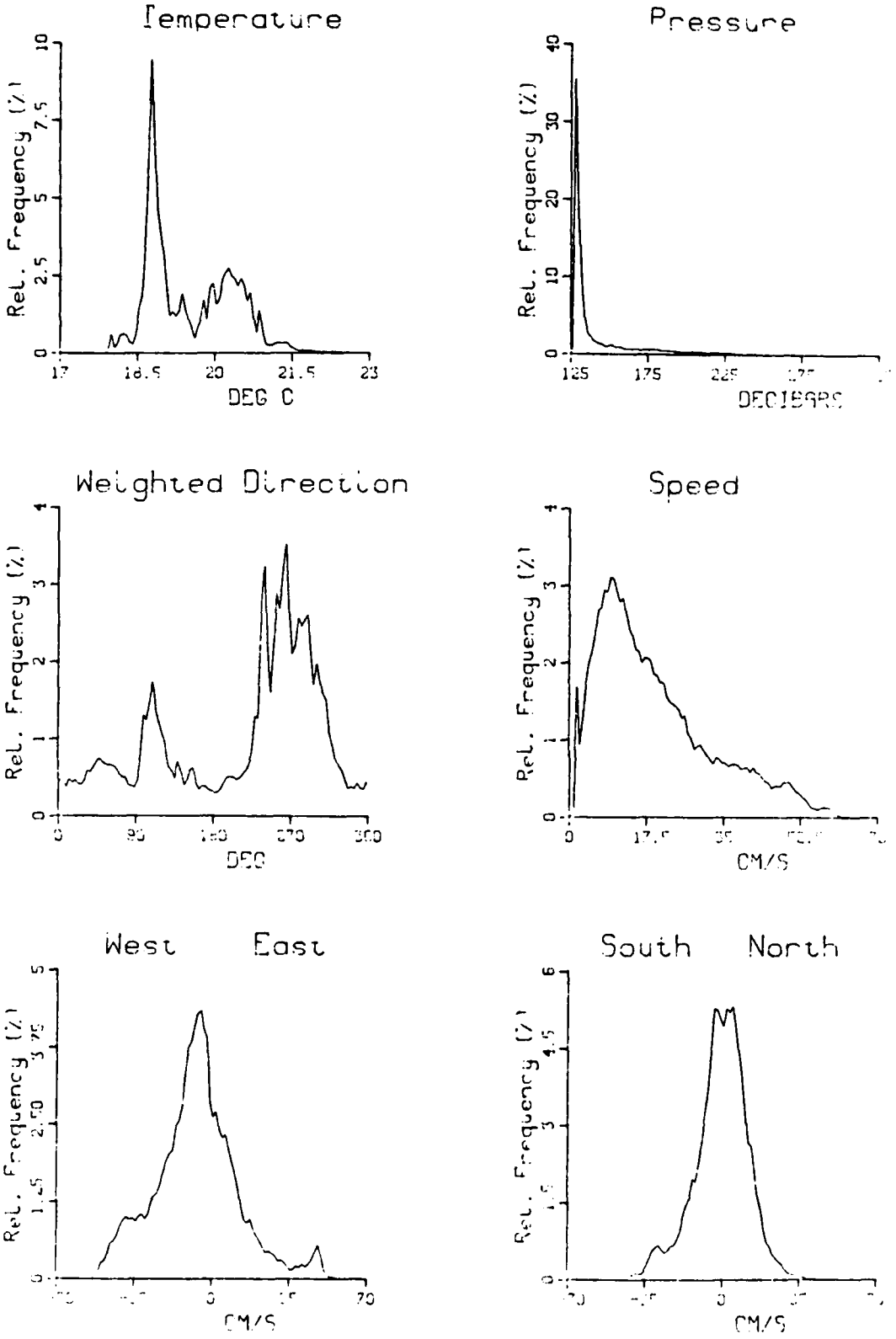

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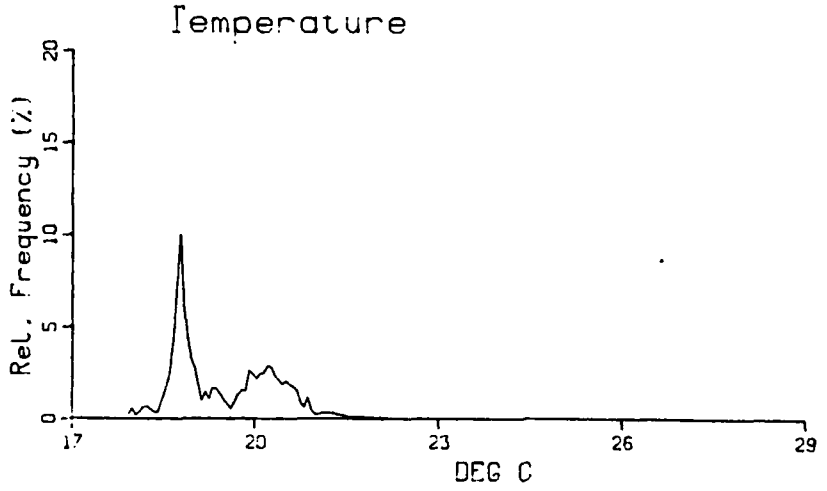

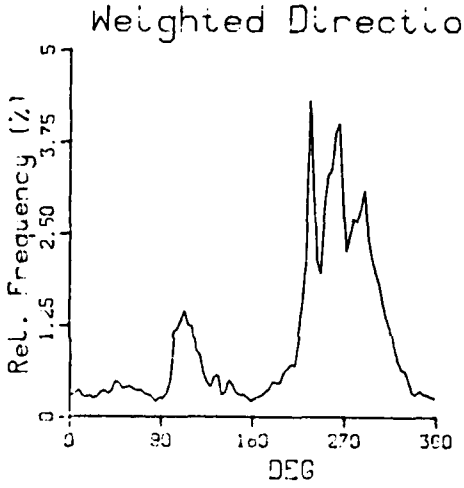

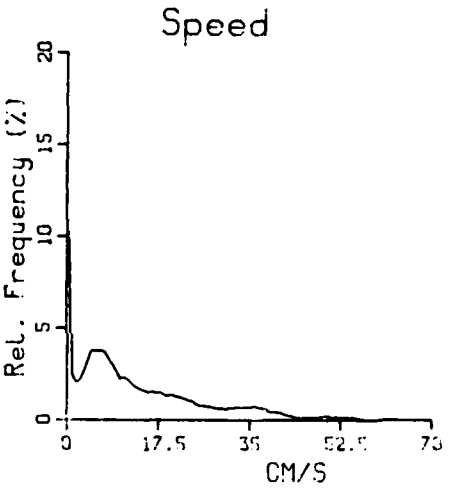

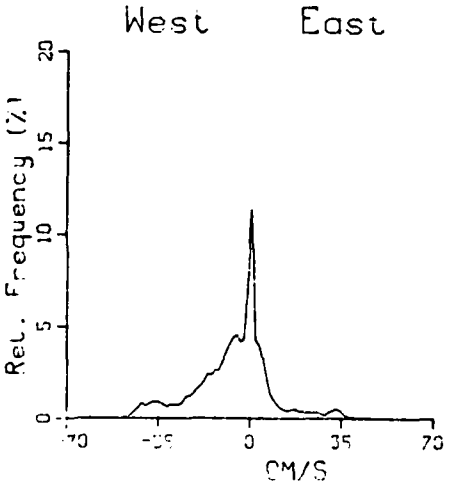

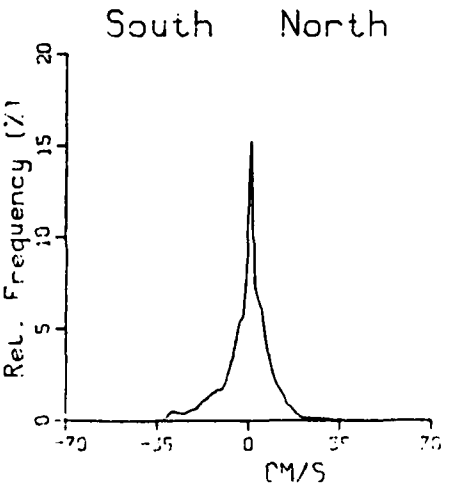

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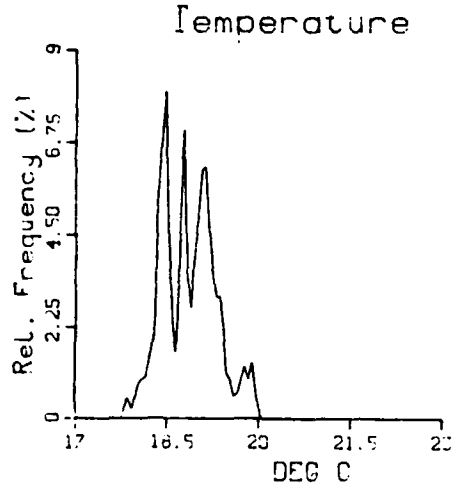

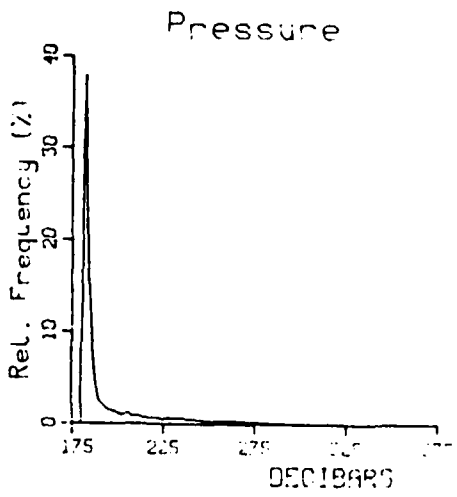

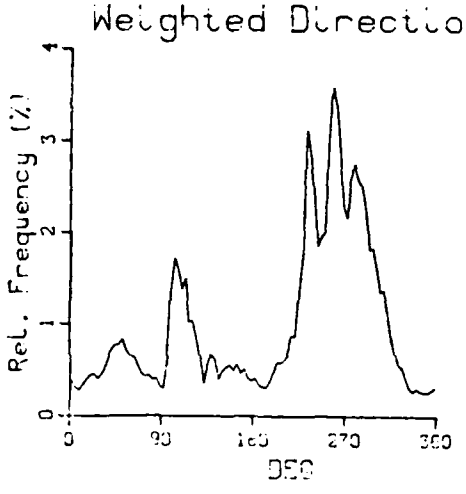

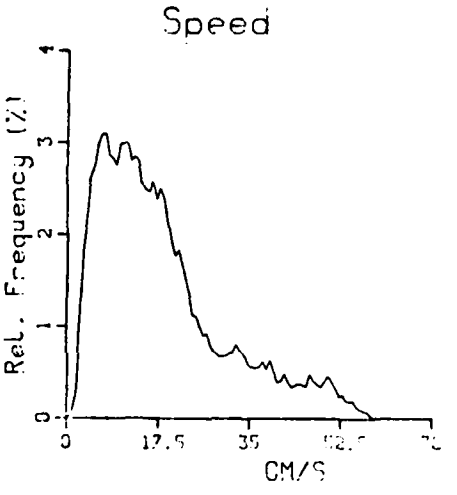

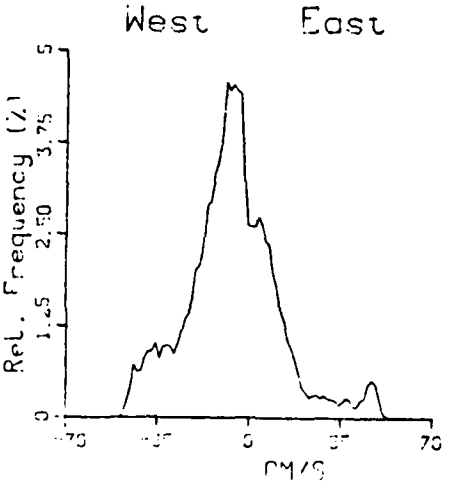

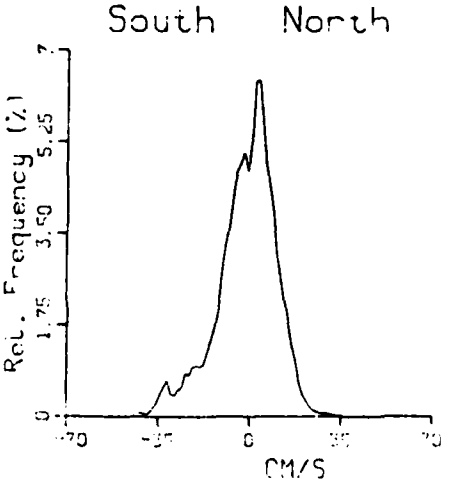

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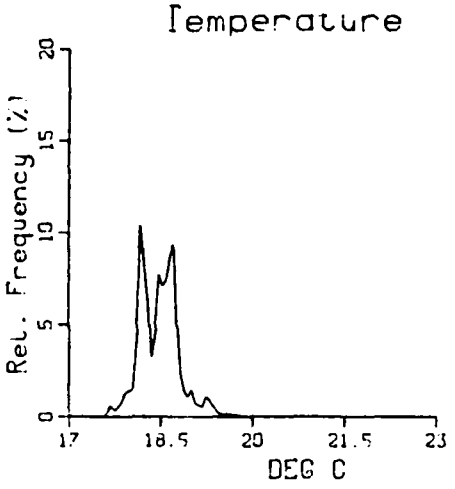

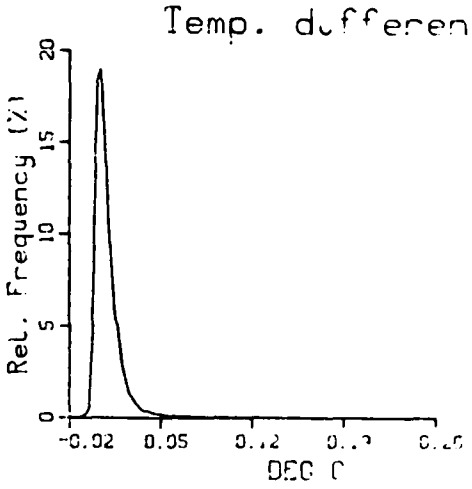

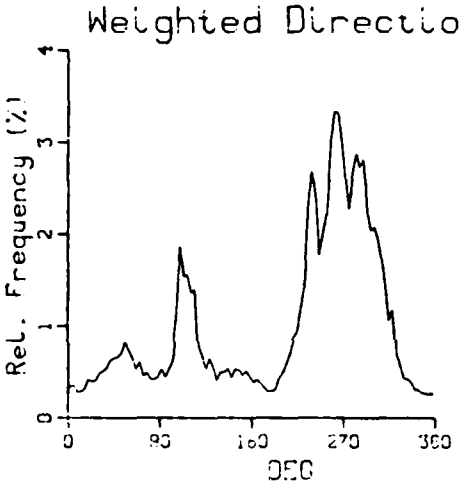

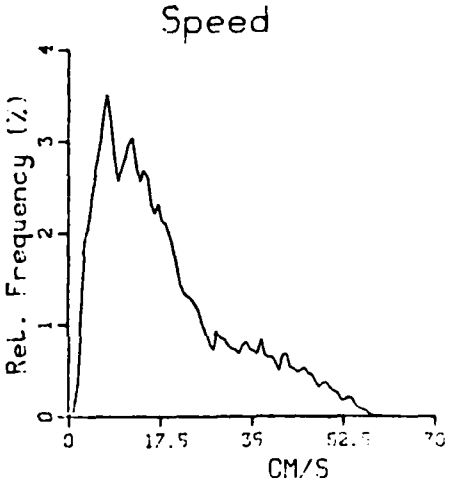

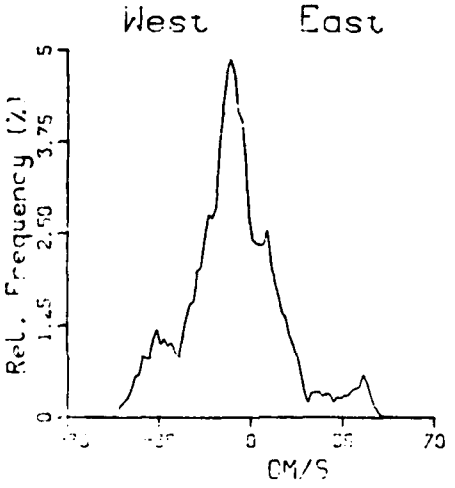

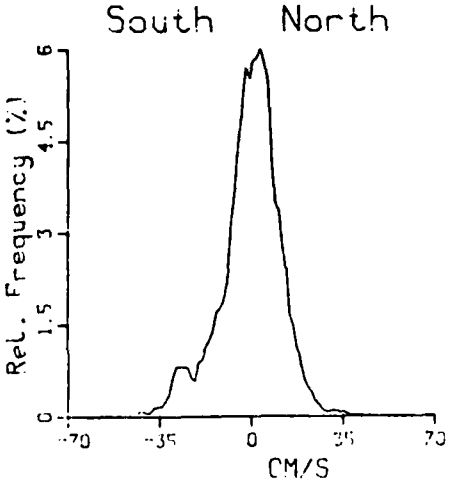

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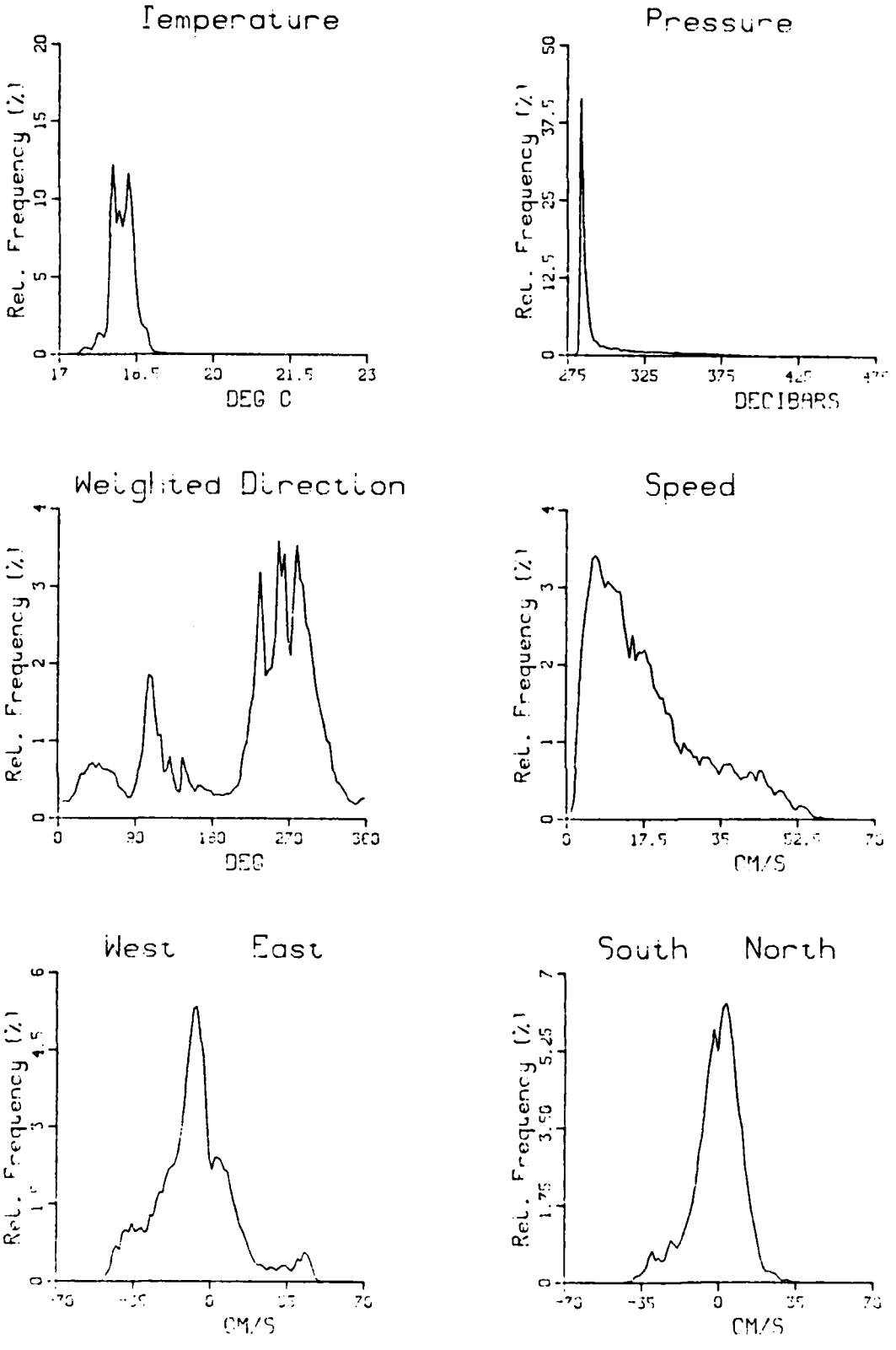

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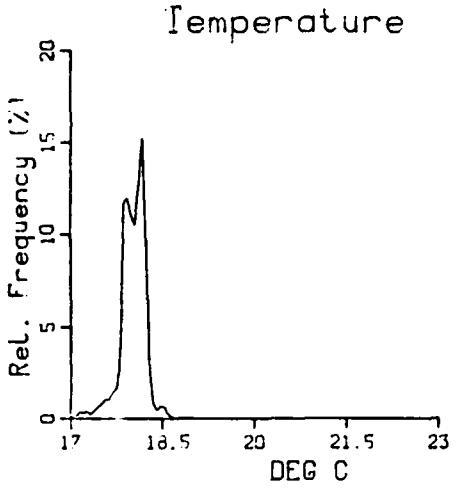

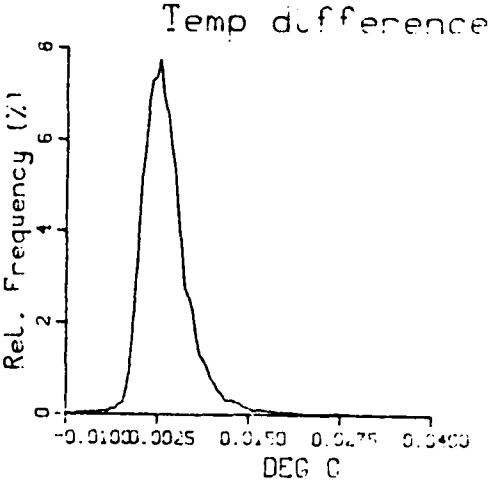

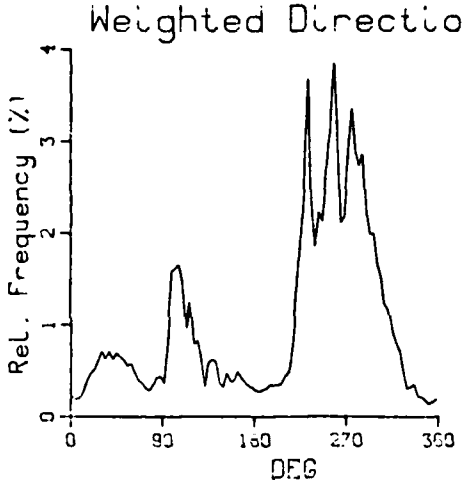

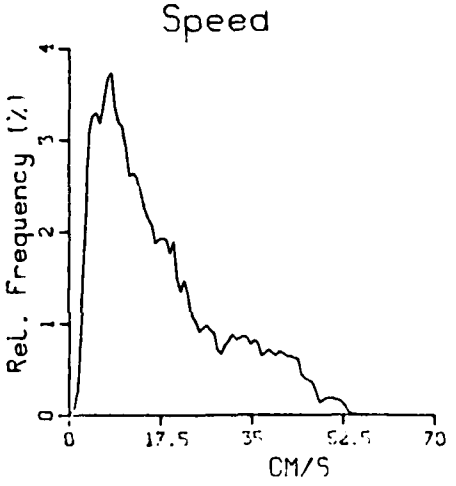

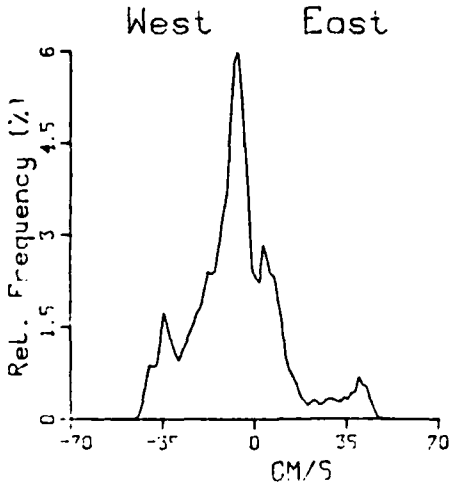

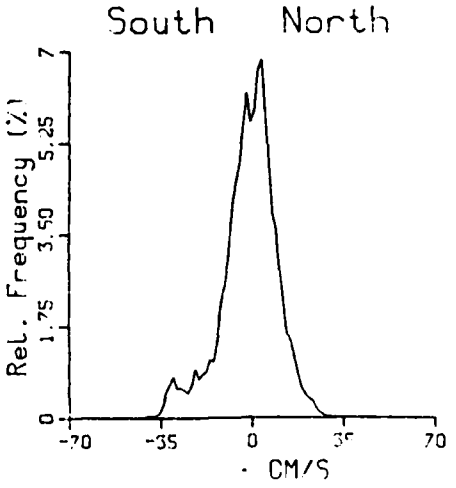

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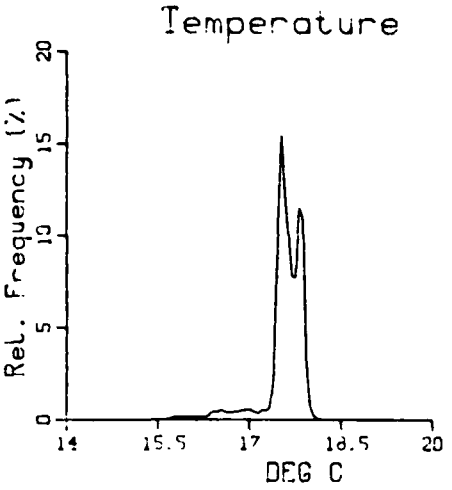

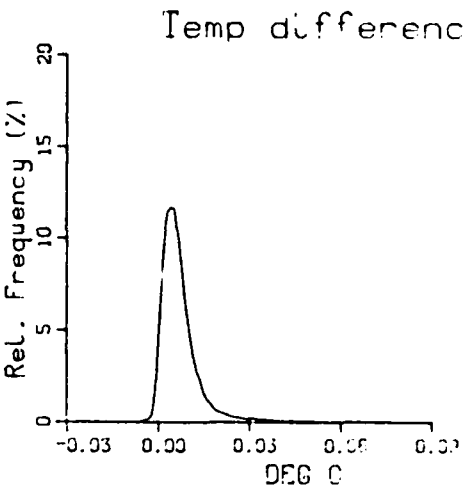

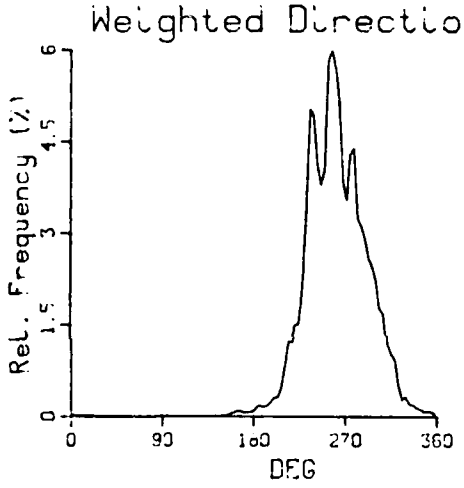

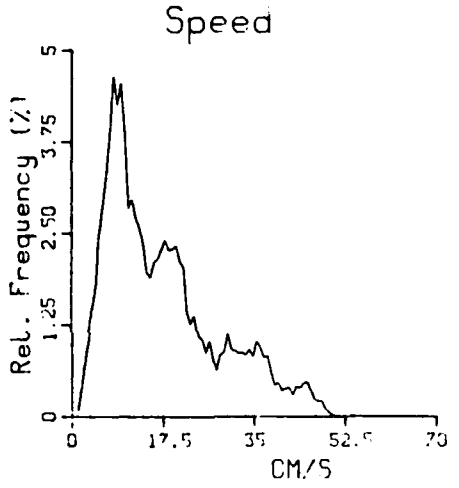

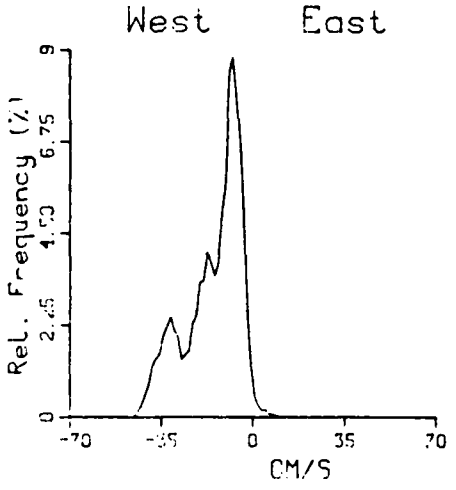

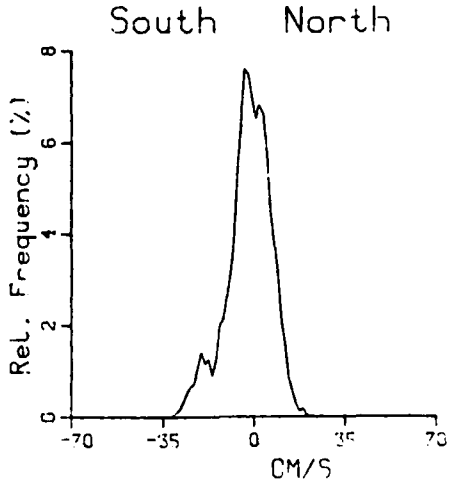

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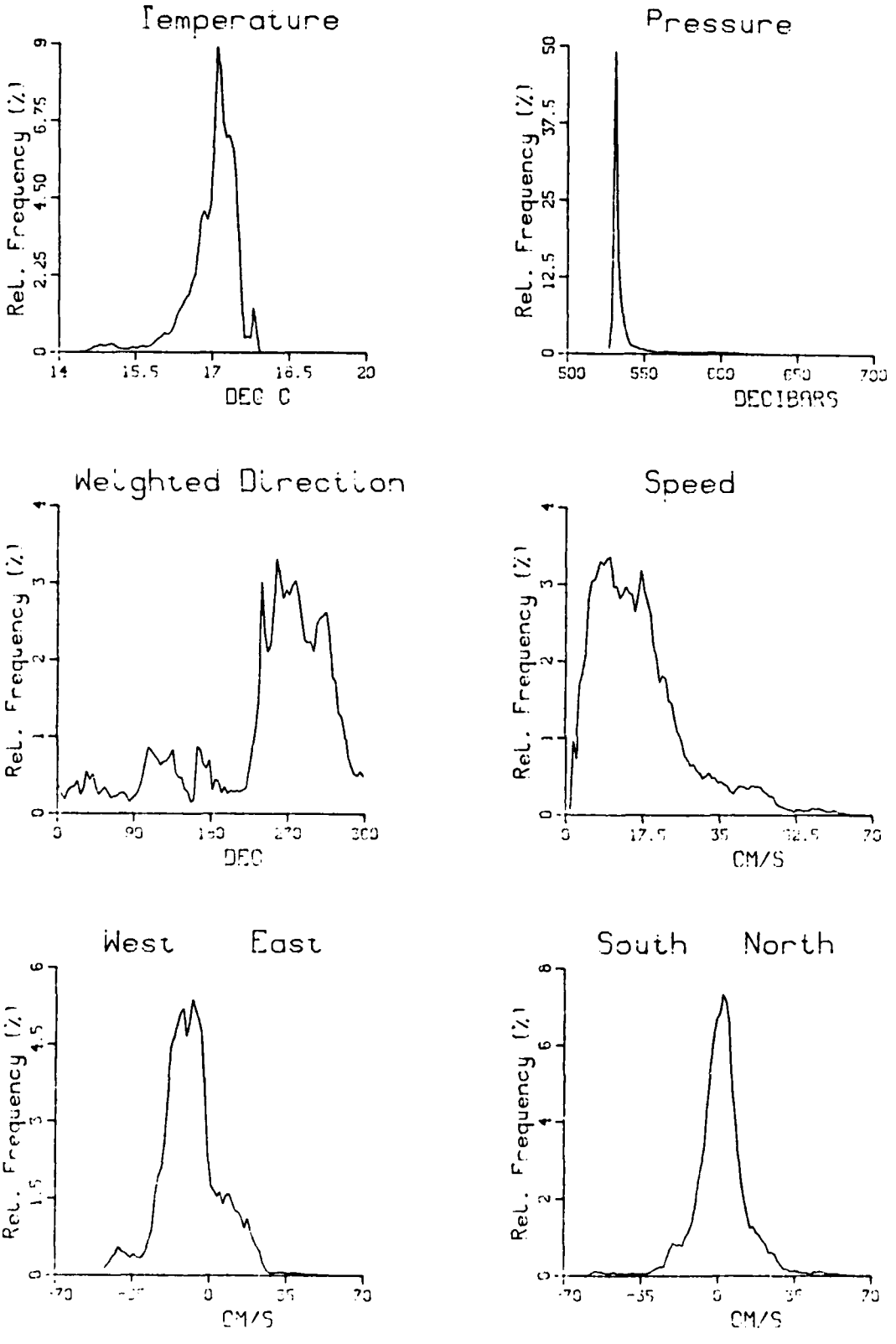
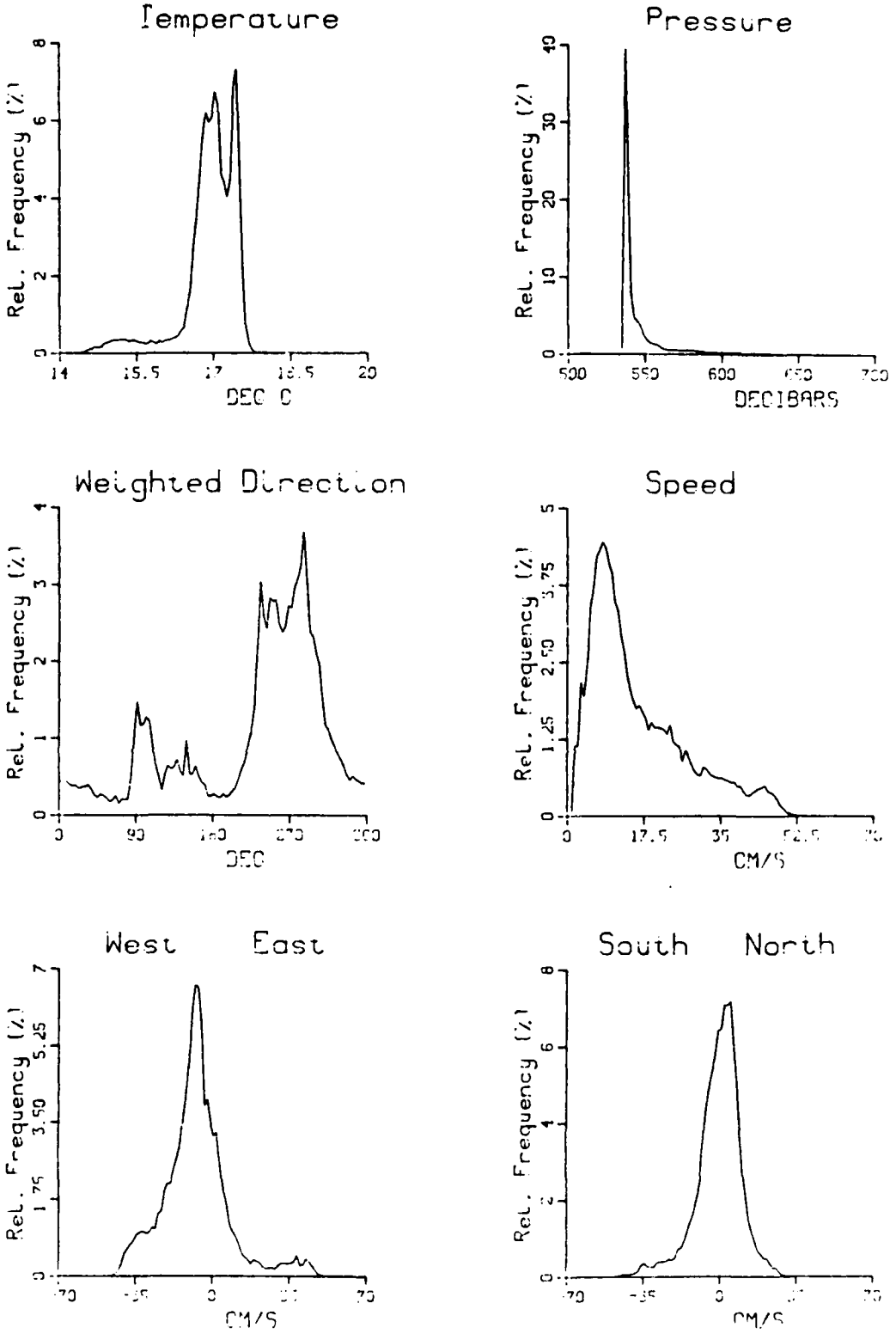


Data File 76410450 · Depth = 527 m



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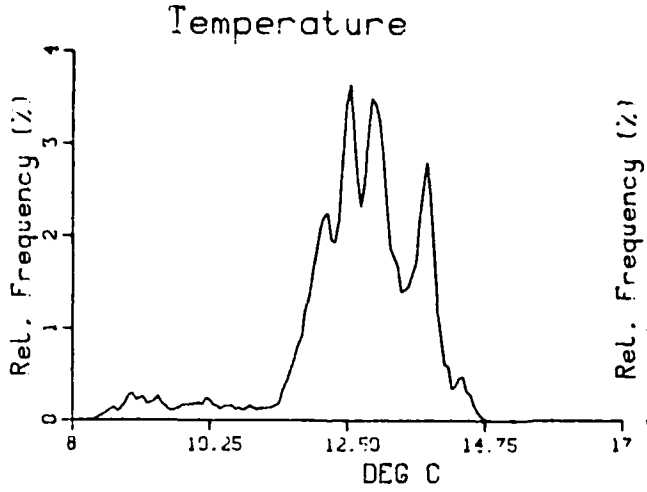

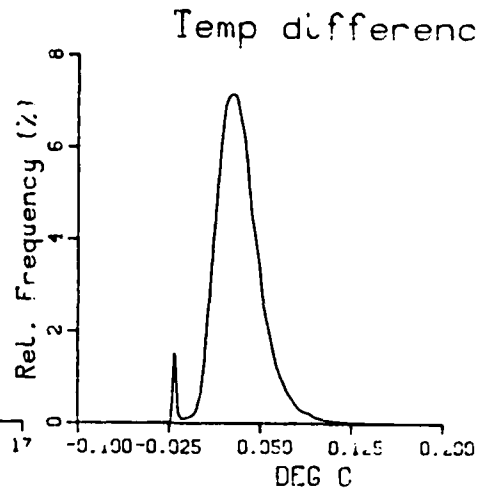

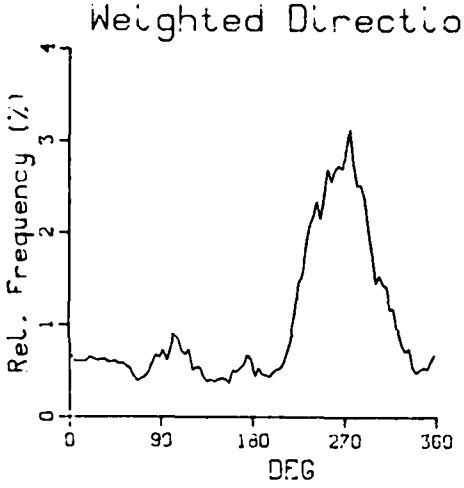

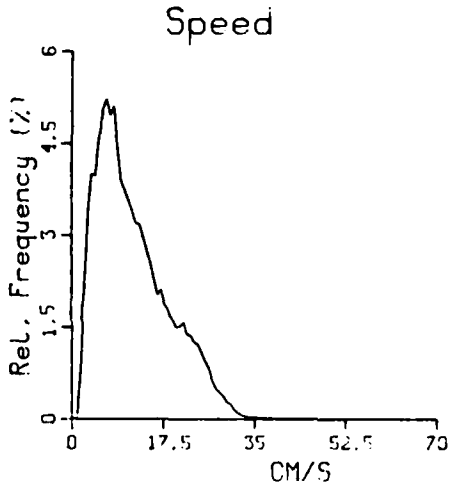

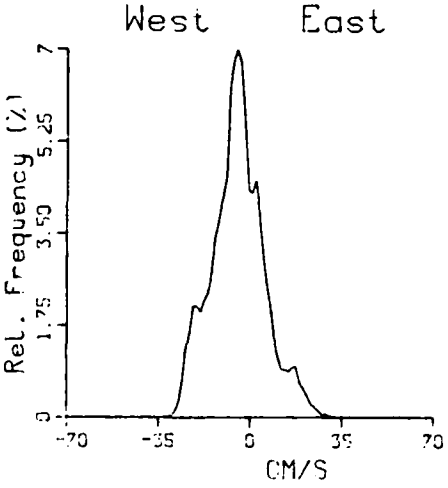

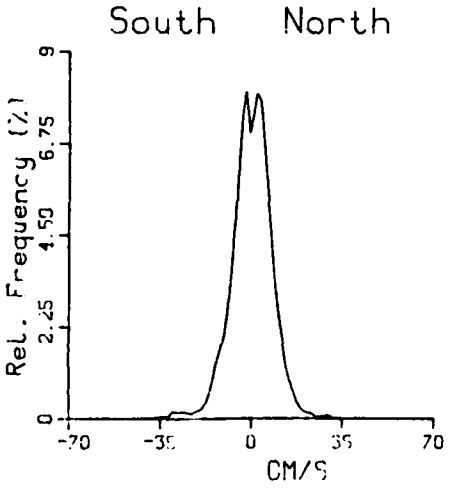

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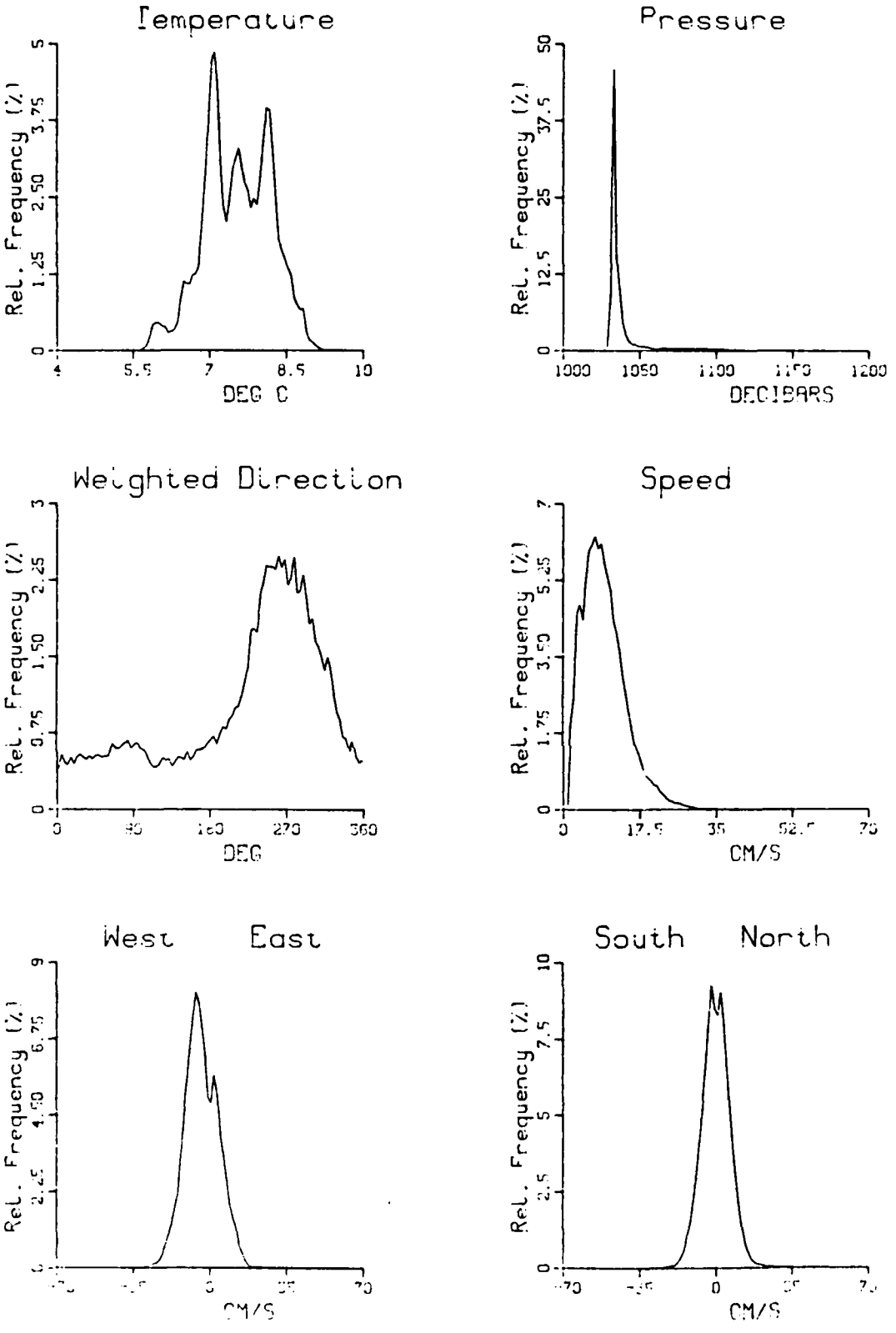

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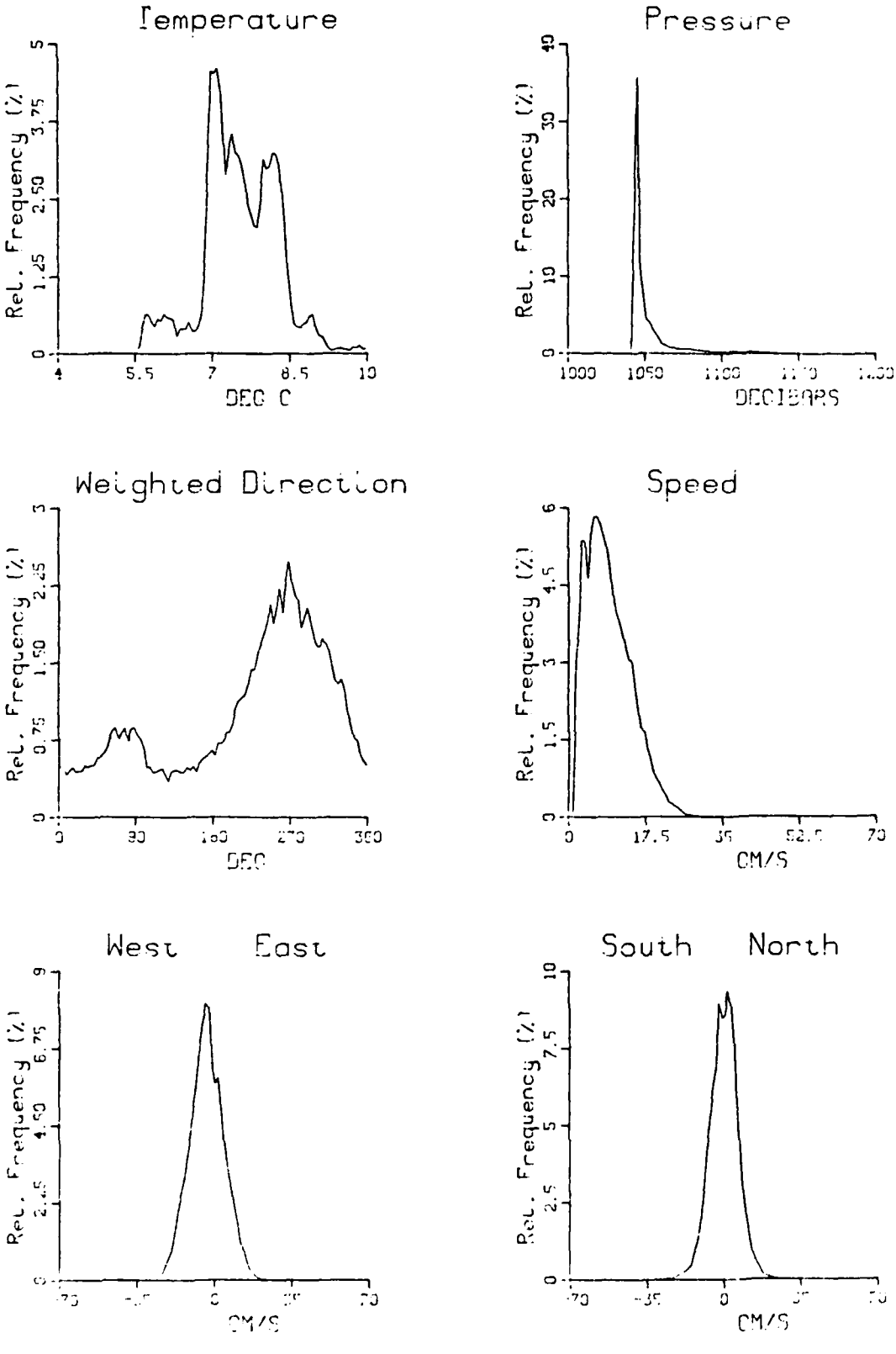

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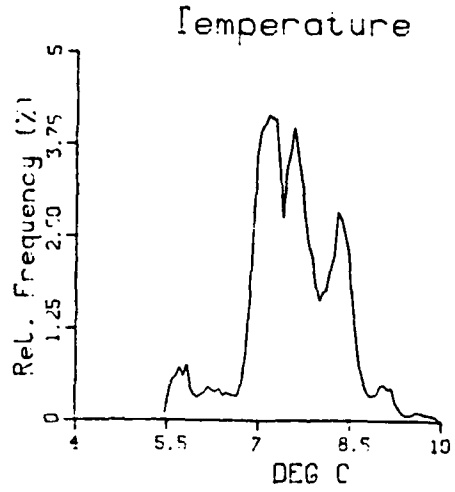

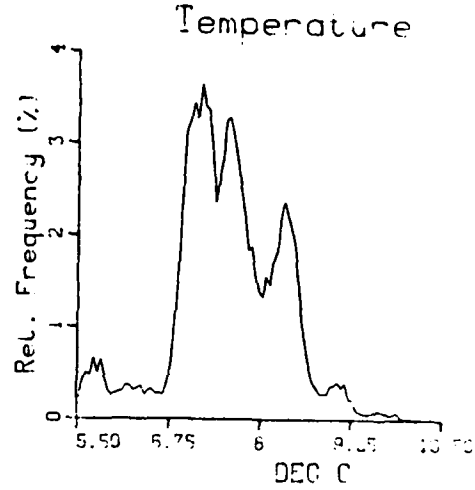

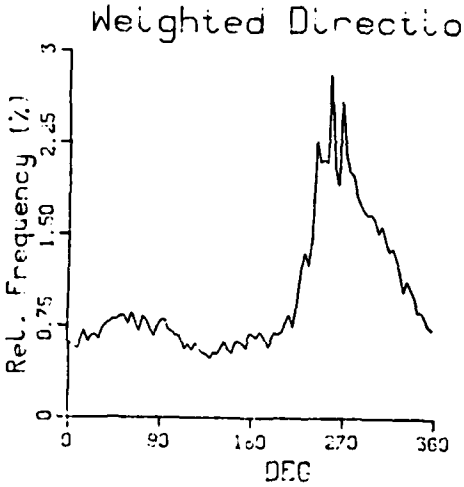

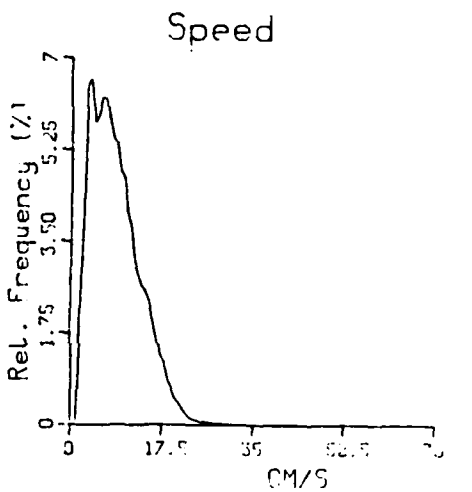

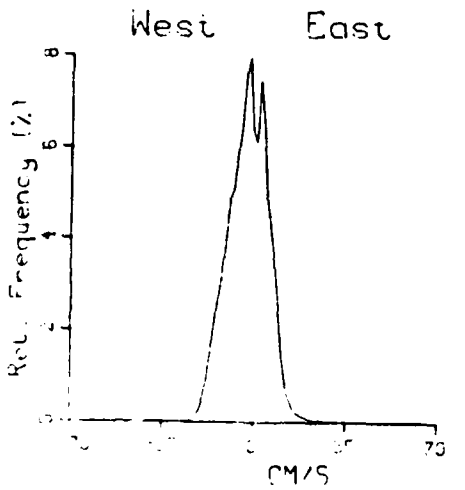

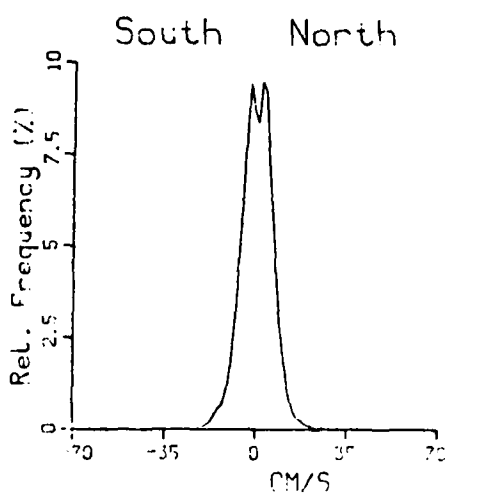

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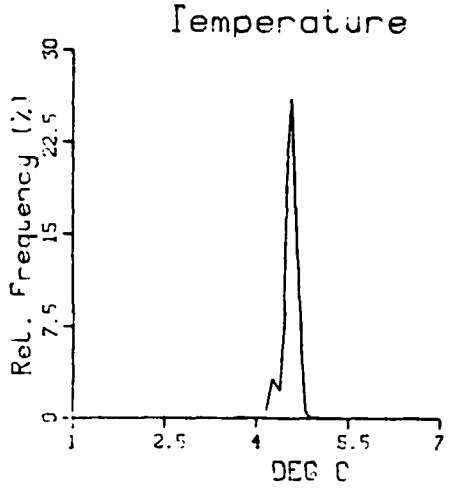
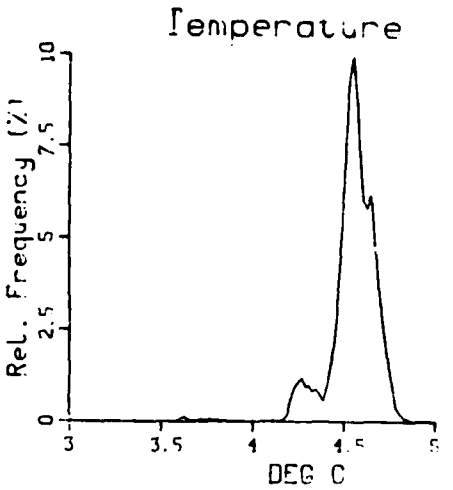
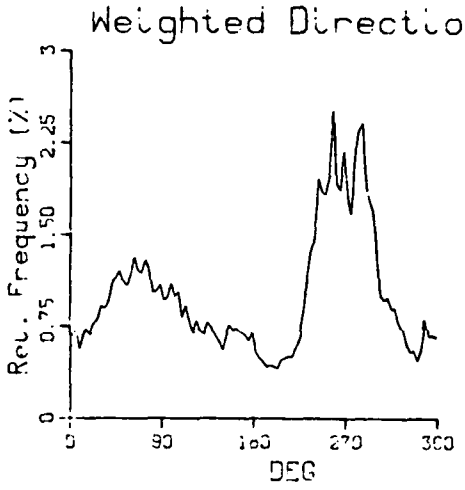
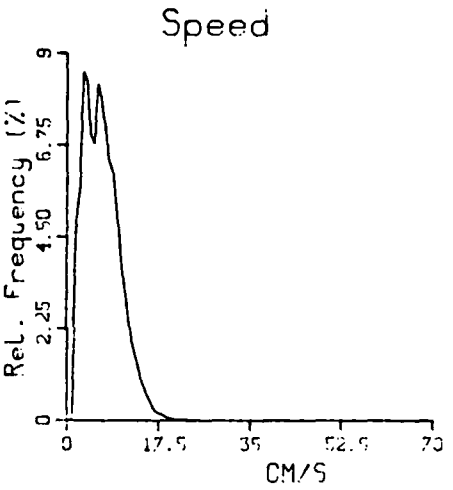
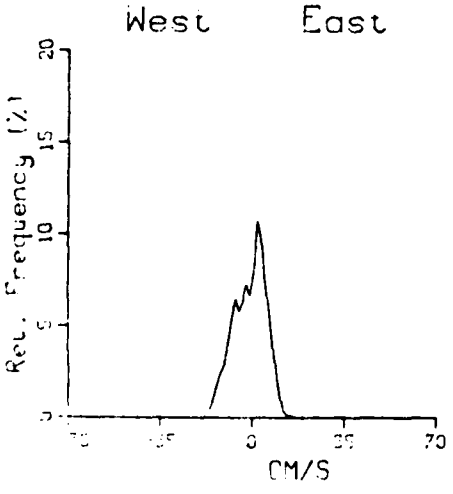
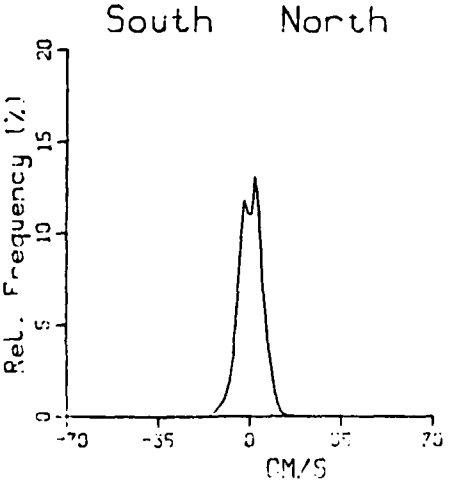




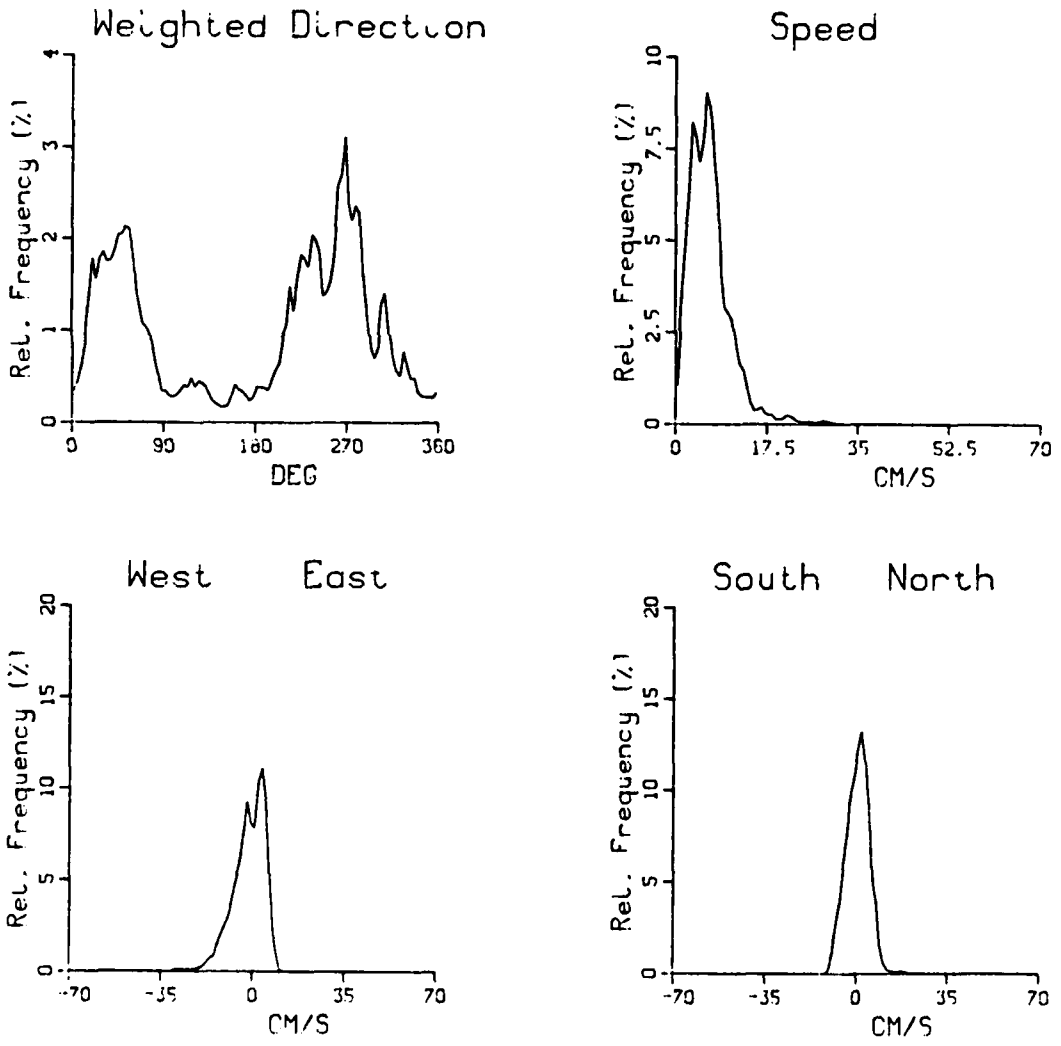




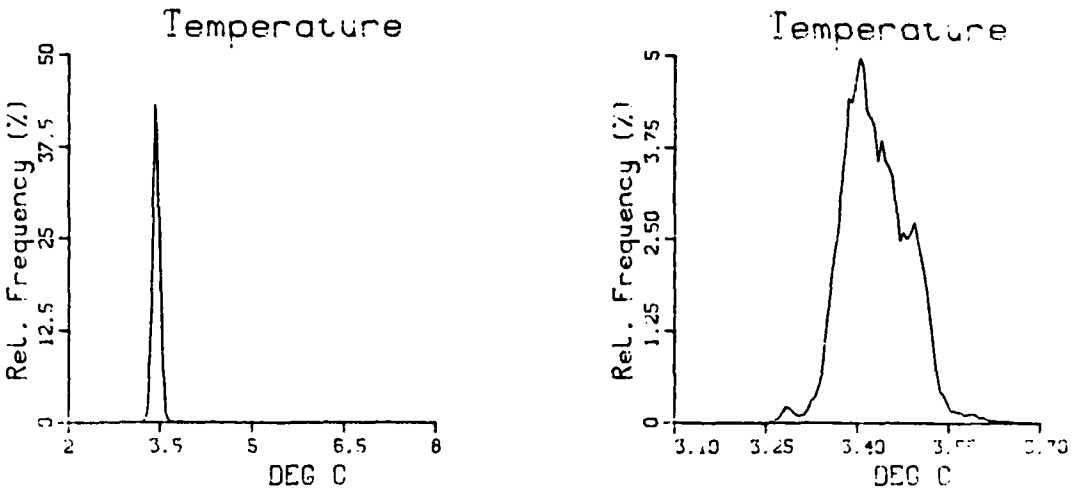




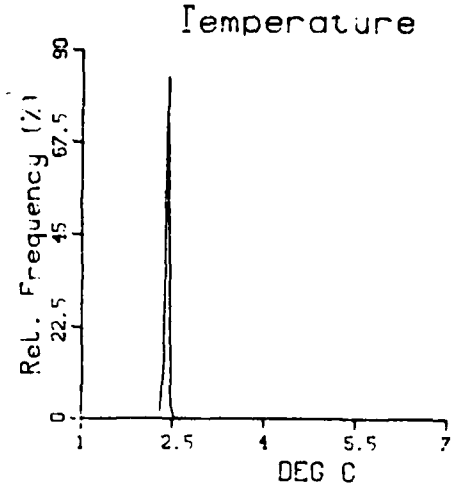
Data File 766130450 : Depth = 1521m

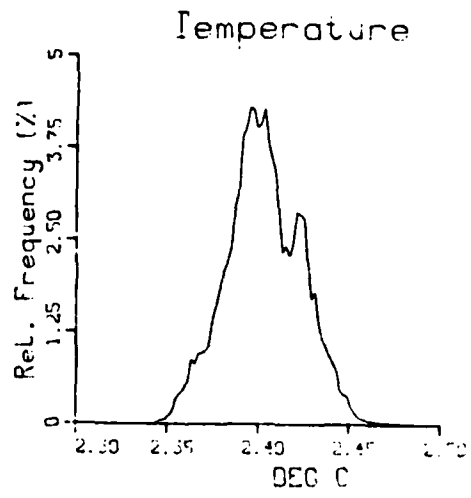


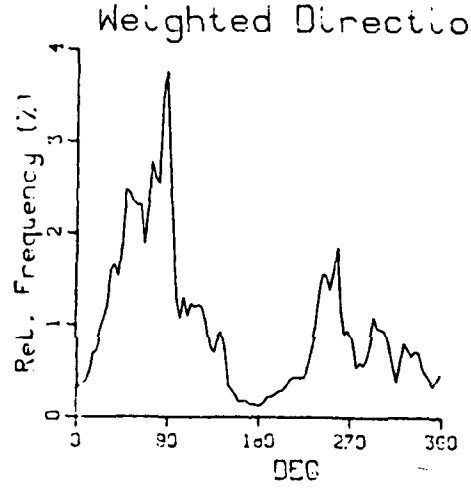
Data File 770140225 : Depth = 2500m

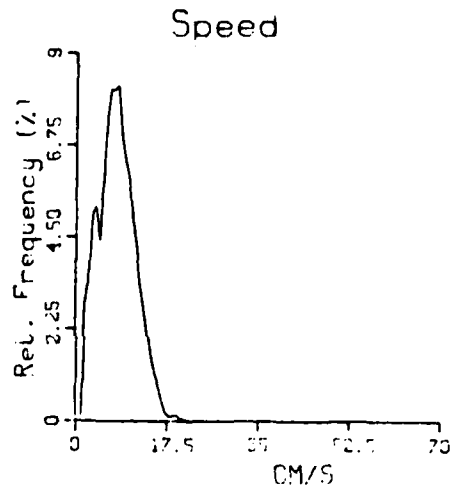


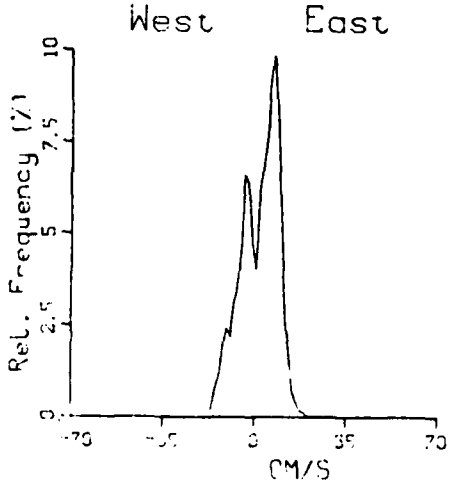
Data File 76614C450 : Depth = 2516m

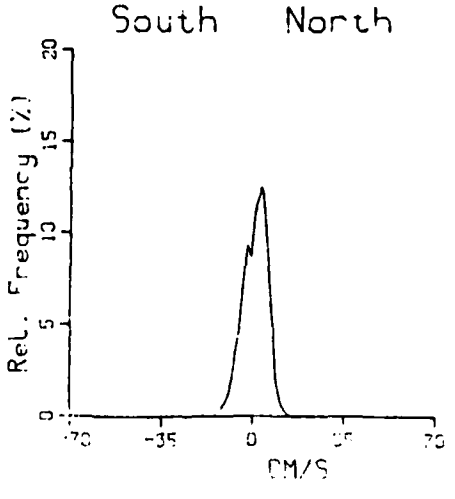












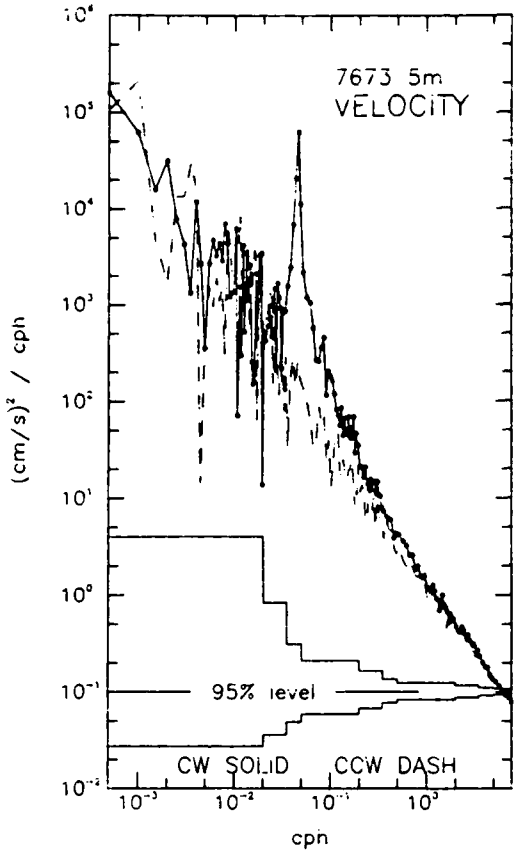
Data File 766150450 Depth = 4007 m

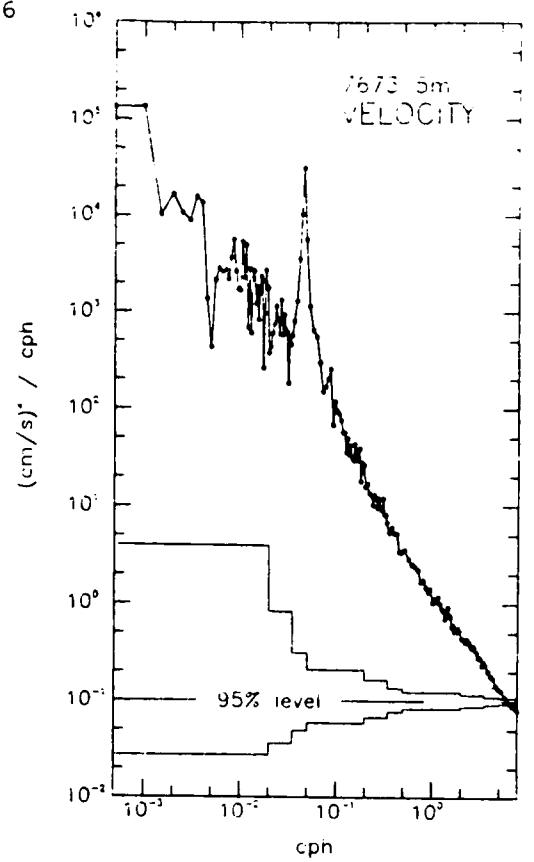
SPECTRA

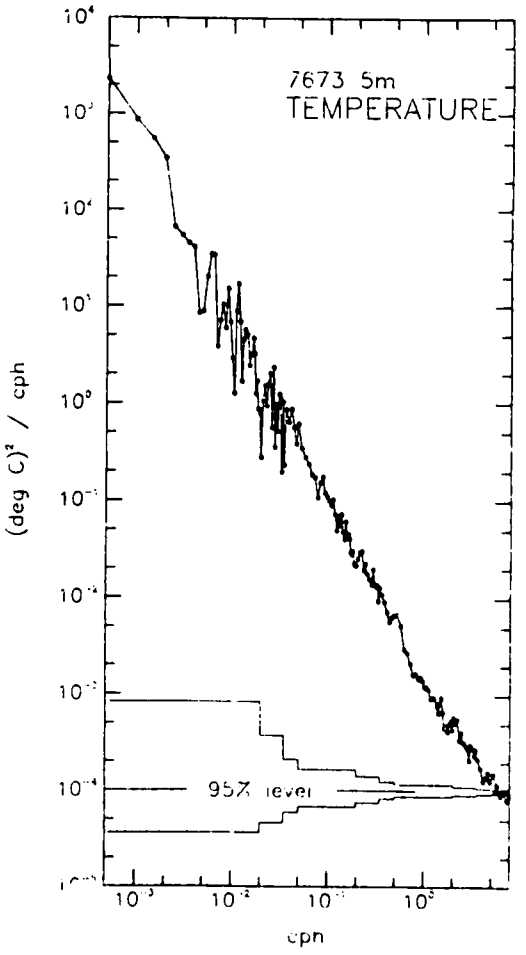
Table 4

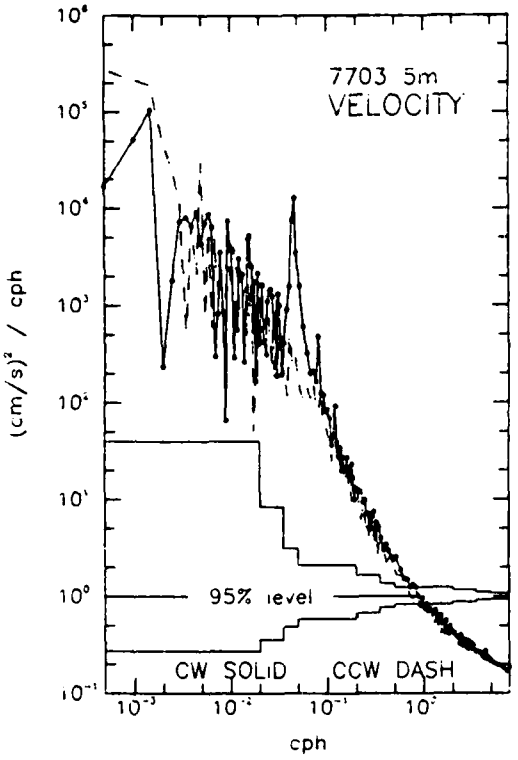
Spectral Plots 450 second sampled data has a piece length of 16000.
225 second sampled data has a piece length of 32000.
A table of the number of pieces, number of data cycles follows.

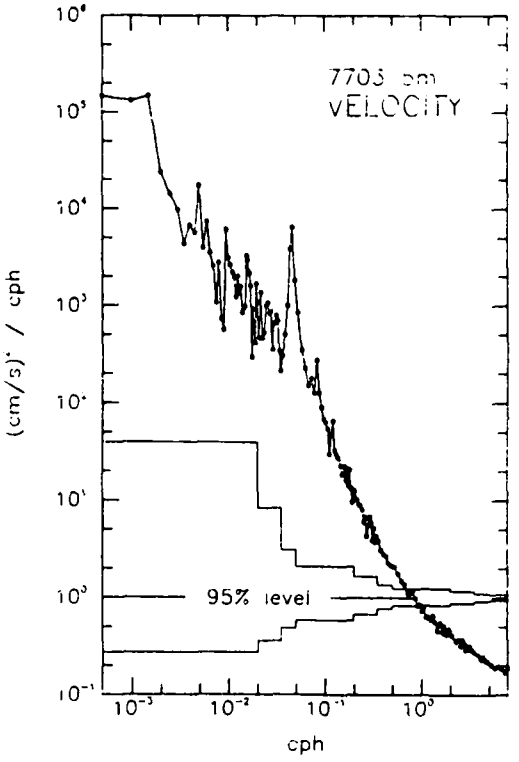
Data Name	Samp Rate (sec)	Var	Number of Points	Number of Pieces
767S1	225	all	61934	1
767S2	225	all	38677	1
7673	225	vel	34800	1
	225	temp	65296	2
7674	225	all	65296	2
7675	225	all	65296	2
7676	225	all	65296	2
7677	225	all	65296	2
7678	225	all	65296	2
7679	225	all		2
76710	225	all	65296	2
76711	225	all	65296	2
76712	225	all	65296	2
770S1	450	all	21113	1
770S2	450	all	21113	1
7703	225	all	42225	1
7704	225	all	42225	1
7705	225	all	42225	1
7706	225	temp	42225	1
	225	vel	38033	1
7707	225	all	42225	1
7708	225	temp	42225	1
	225	vel	19208	1
7709	225	temp	42225	1
77014	225	vel	42225	1
7641	450	all	65000	4
7642	450	all	65000	4
7651	450	all	65000	4
7652	450	all	65000	4
7661	450	all	64500	4
7662	450	all	64500	4
7663	450	all	64500	4
7664	450	all	64500	4
7665	450	all	64500	4
7666	450	all	64500	4
7667	450	temp	50121	3
		tdif	50121	3
		vel	30729	1
76611	450	all	64500	4
76612	450	all	64500	4
76613	450	all	64500	4
76614	450	temp	64500	4
76615	450	all	64500	4

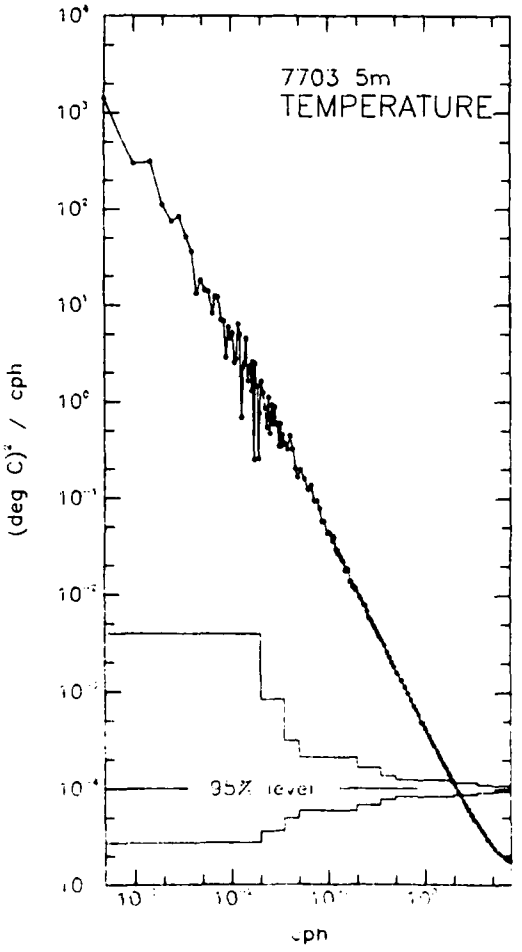

7673 5m
VELOCITY
95% level
CW SOLID CCW DASH
(cm/s)² / cph
cph

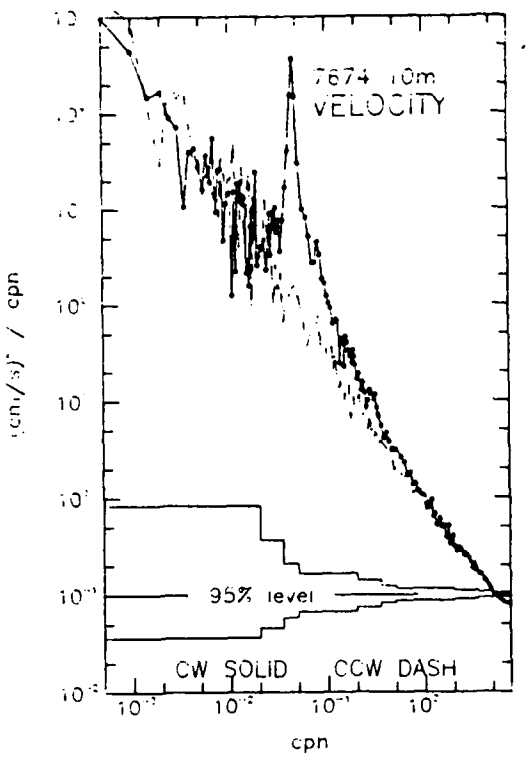

7673 5m
VELOCITY
95% level
(cm/s)² / cph
cph

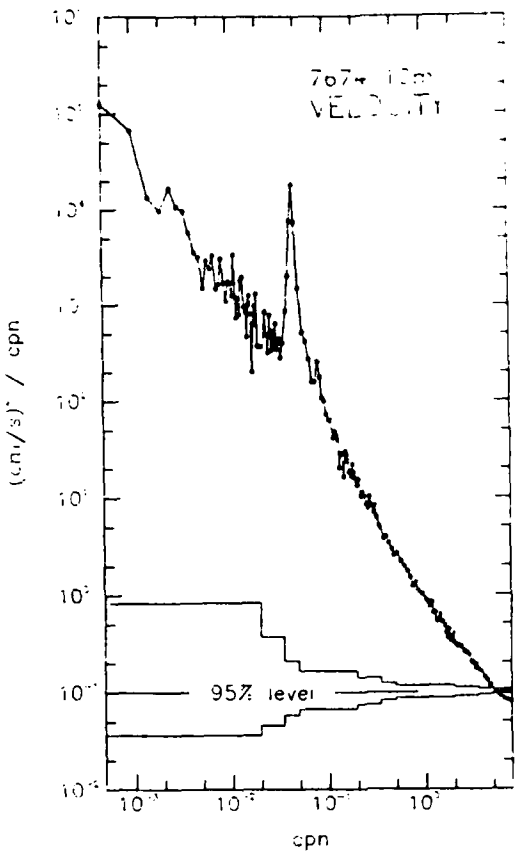

7673 5m
TEMPERATURE
95% level
(deg C)² / cph
cph

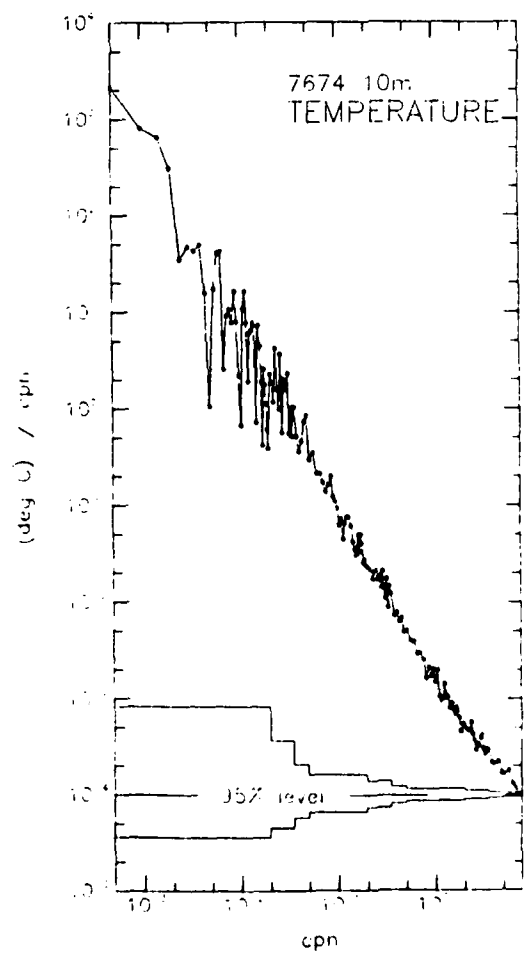

7703 5m
VELOCITY
95% level
CW SOLID CCW DASH
(cm/s)² / cph
cph

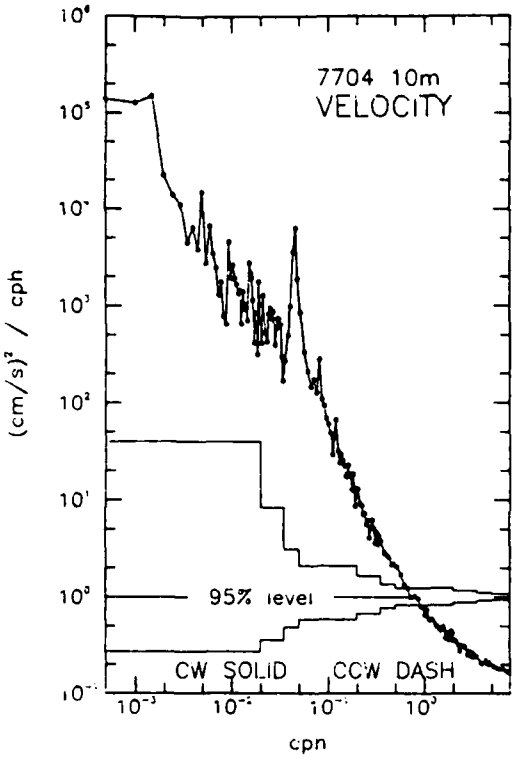

7703 5m
VELOCITY
95% level
(cm/s)² / cph
cph

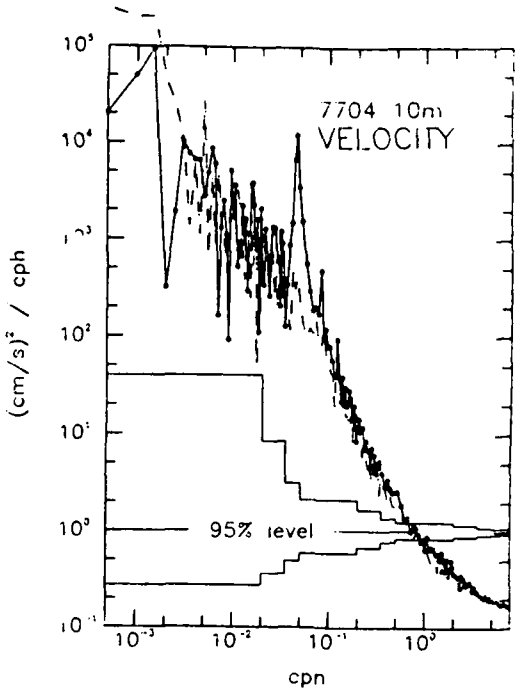

7703 5m
TEMPERATURE
95% level
(deg C)² / cph
cph

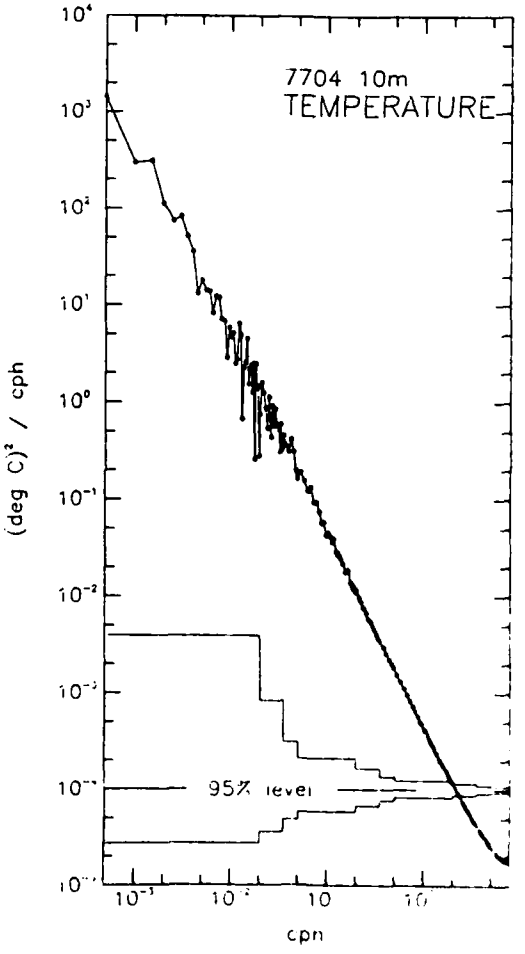

7674 10m
VELOCITY
95% level
CW SOLID CCW DASH
cpn

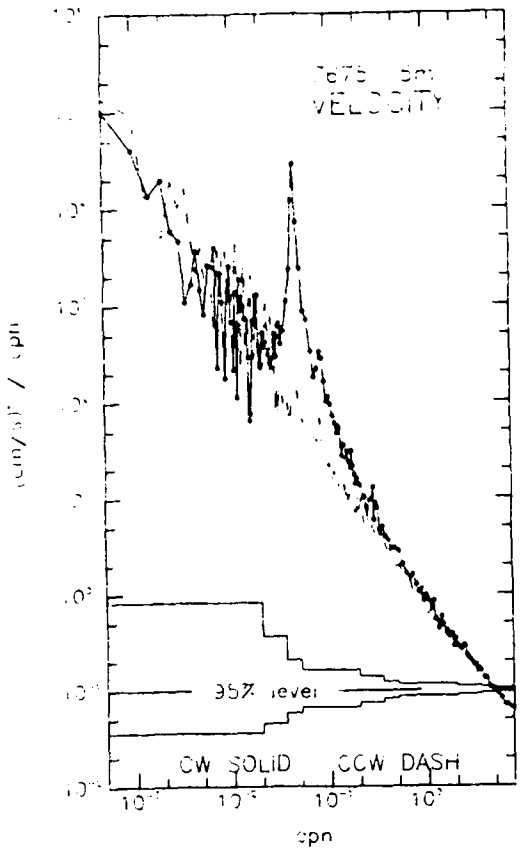

95% level
cpn

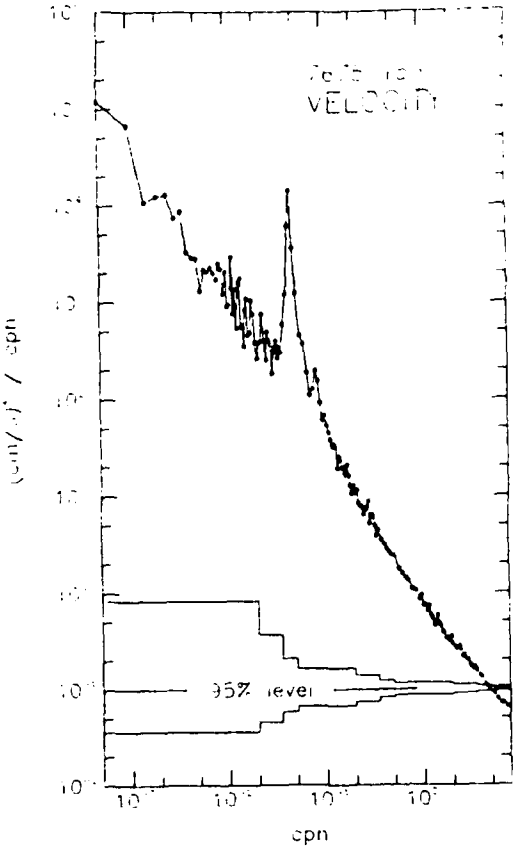

7674 10m
TEMPERATURE
95% level
cpn

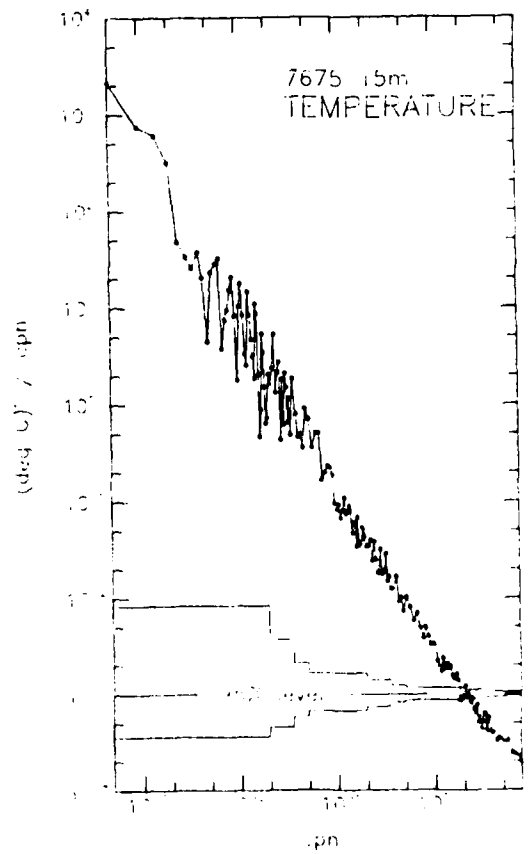

7704 10m
VELOCITY
95% level
CW SOLID CCW DASH
(cm/s)² / cph
cpn

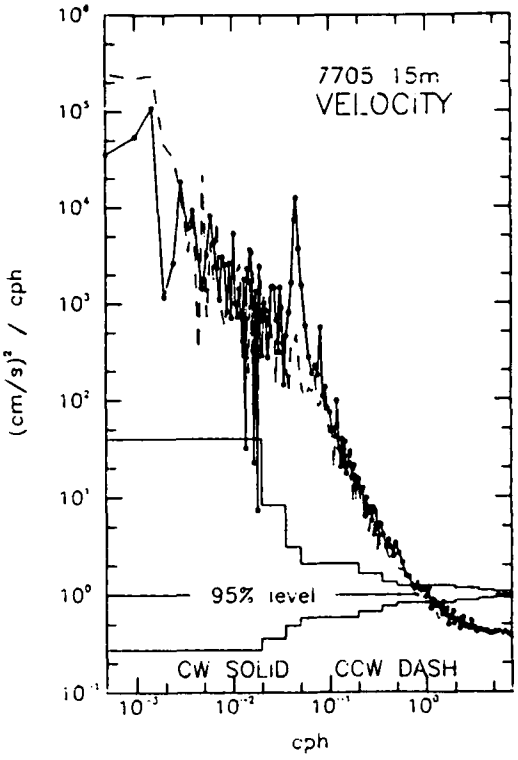

7704 10m
VELOCITY
95% level
(cm/s)² / cph
cpn

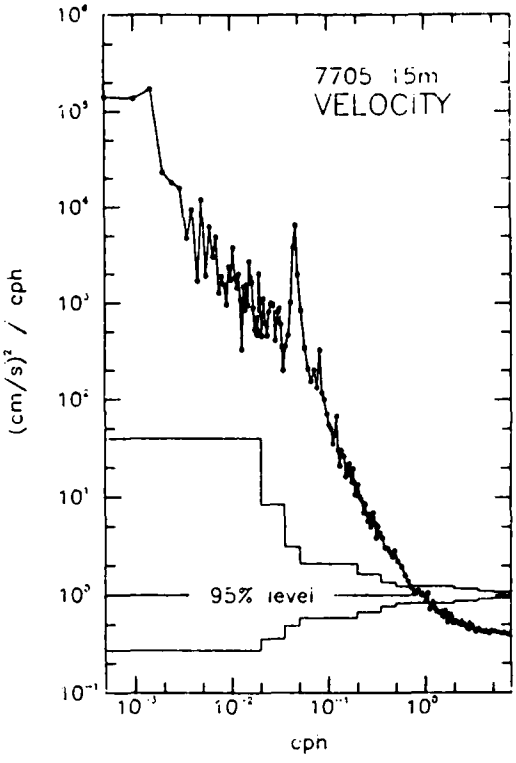

7704 10m
TEMPERATURE
95% level
(deg C)² / cph
cpn

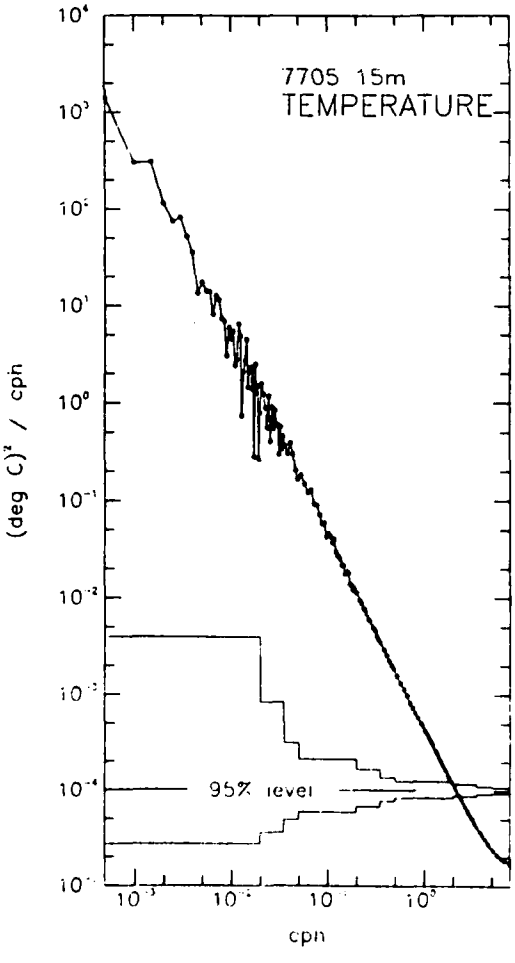

VELOCITY
95% level
CW SOLID CCW DASH
cpn

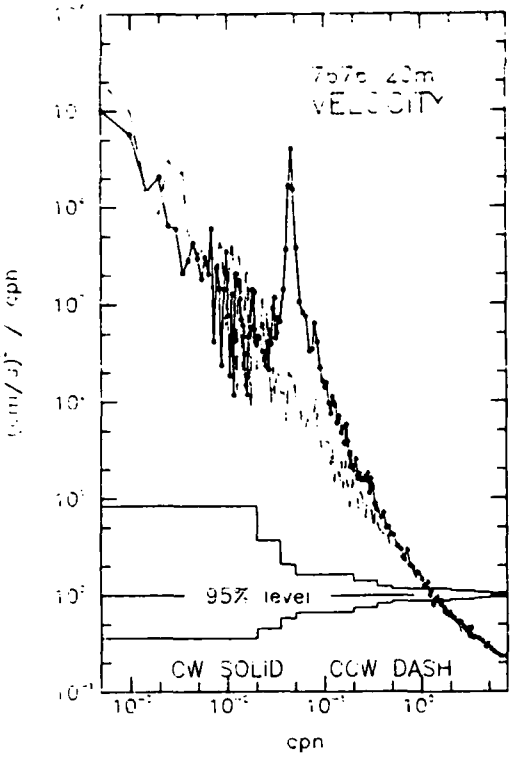

VELOCITY
95% level
cpn

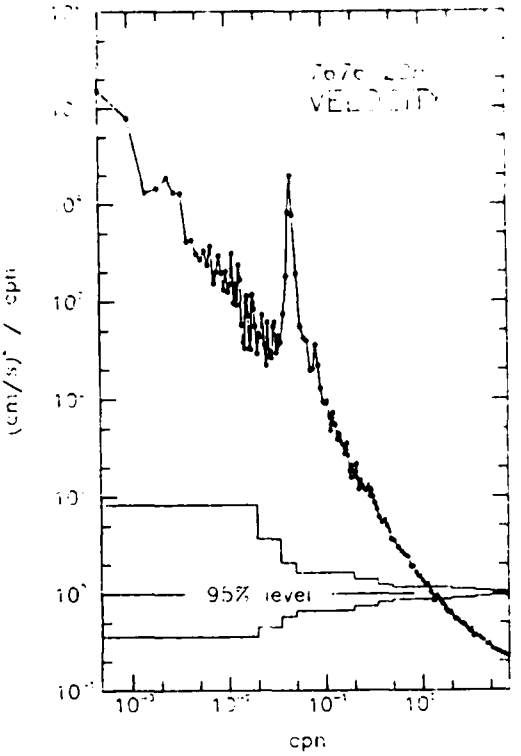

TEMPERATURE
cpn

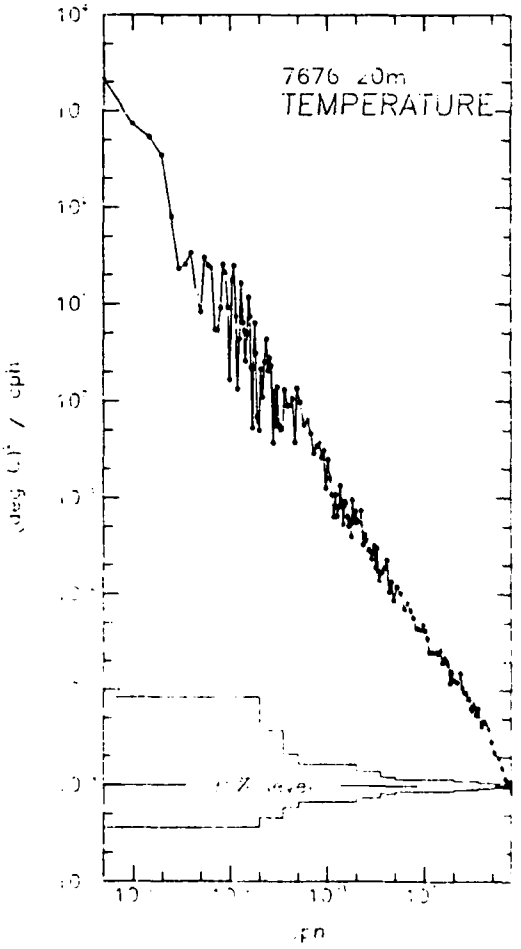

7705 15m
VELOCITY
95% level
CW SOLID CCW DASH
(cm/s)² / cph
cph

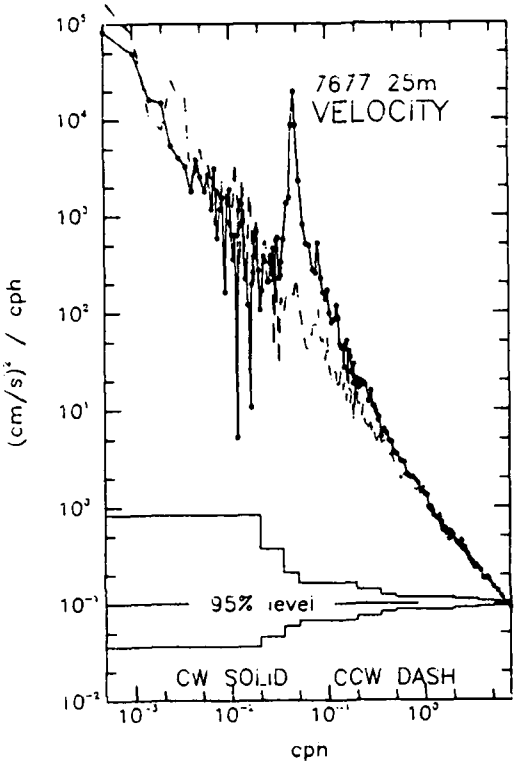

7705 15m
VELOCITY
95% level
(cm/s)² / cph
cpn

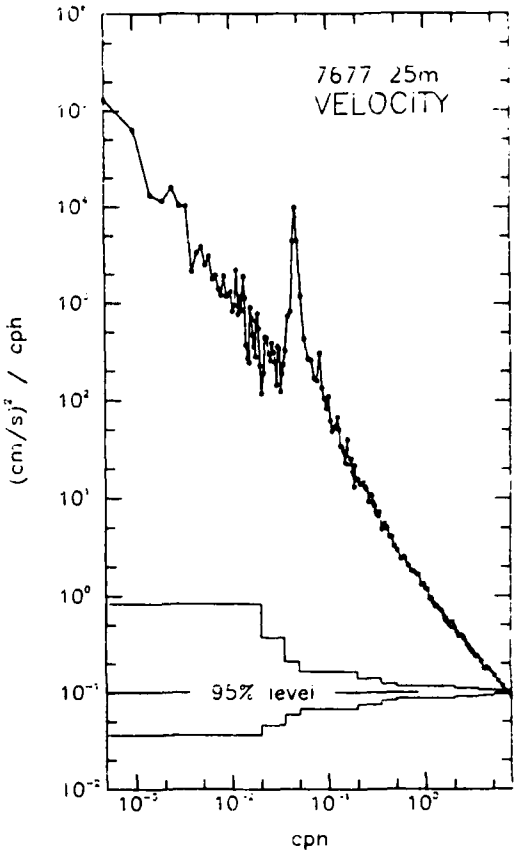

7705 15m
TEMPERATURE
95% level
(deg C)² / cpn
cpn

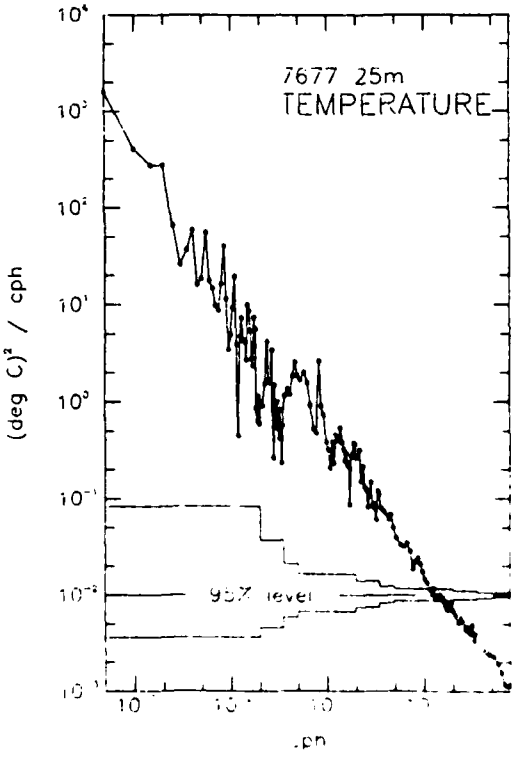

7676 40m
VELOCITY
95% level
CW SOLID CCW DASH
cpn

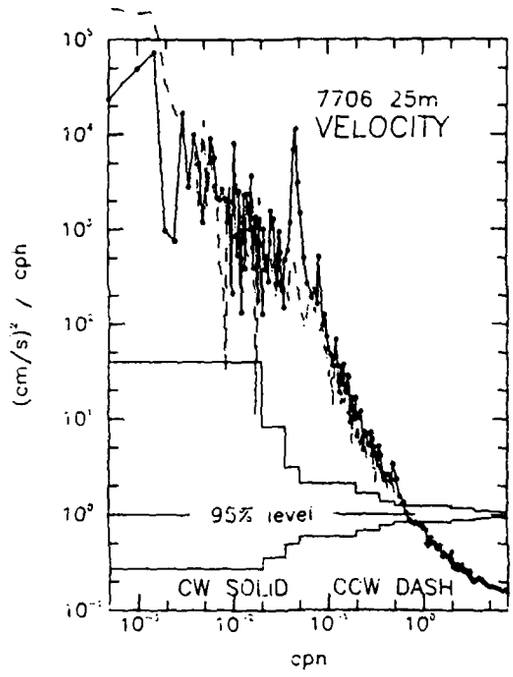

95% level
cpn

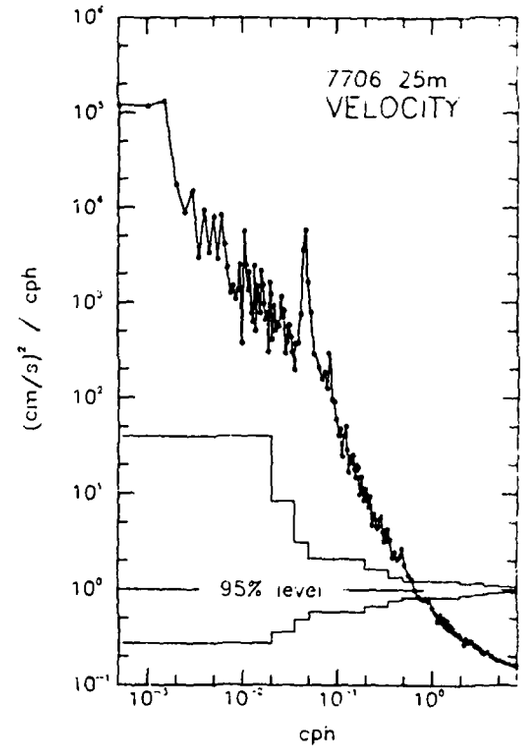

7676 40m
TEMPERATURE
cpn

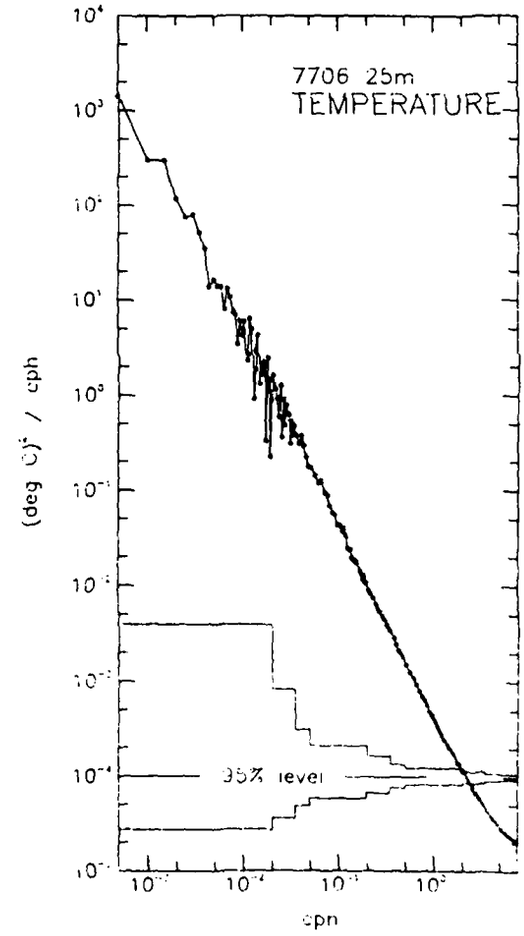

7677 25m
VELOCITY
95% level
CW SOLID CCW DASH
(cm/s)² / cph
cpn

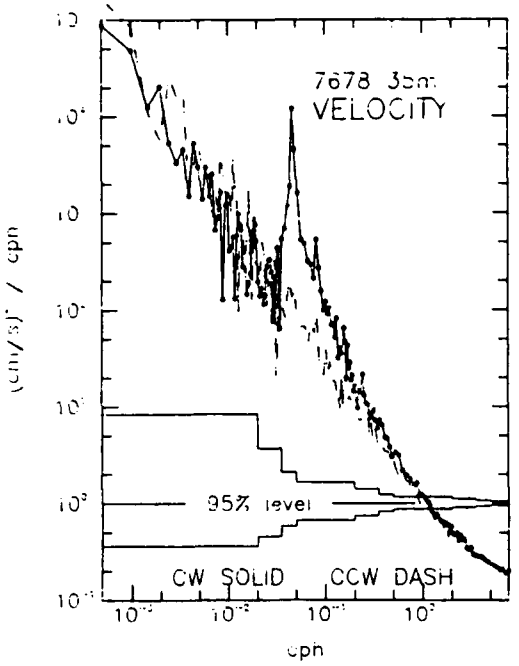

7677 25m
VELOCITY
95% level
(cm/s)² / cph
cpn

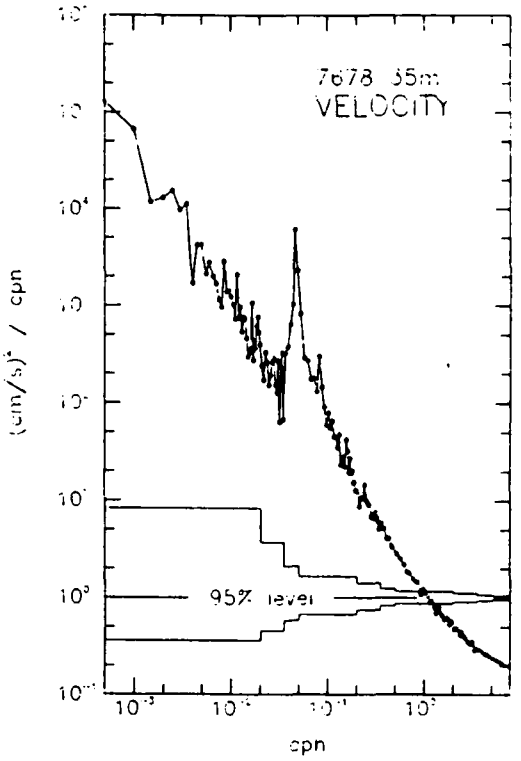

7677 25m
TEMPERATURE
95% level
(deg C)² / cph
cpn

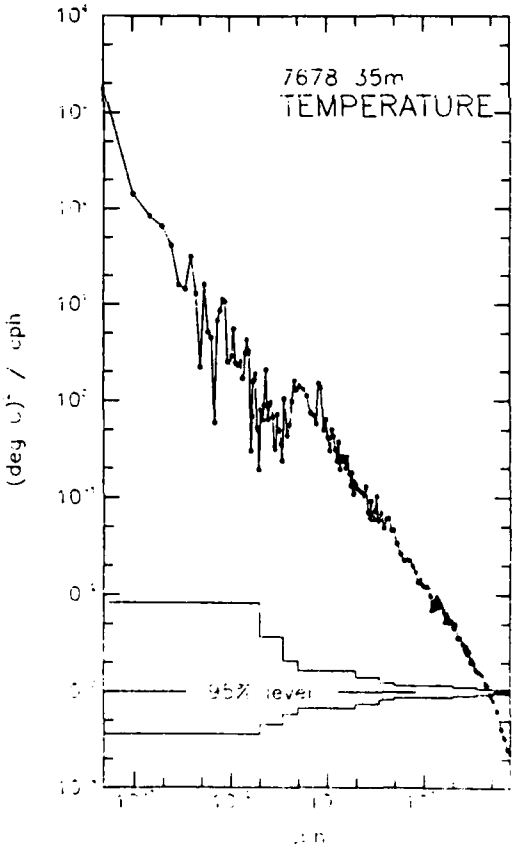

7706 25m
VELOCITY
95% level
CW SOLID CCW DASH
(cm/s)² / cpn
cpn

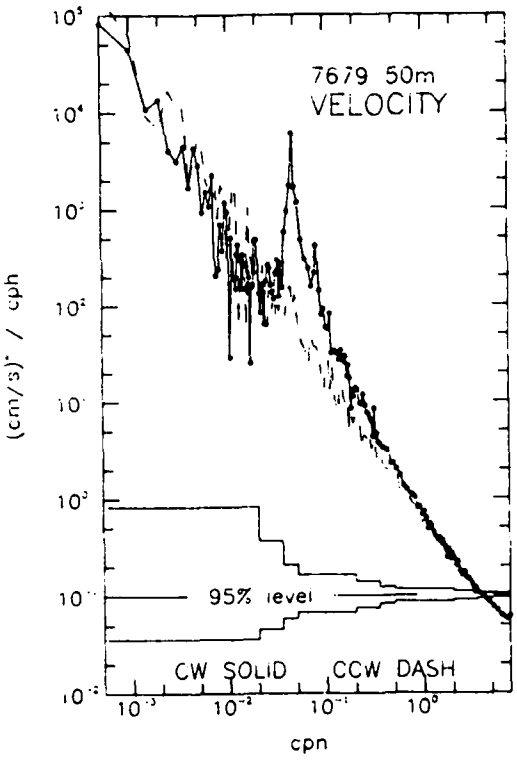

7706 25m
VELOCITY
95% level
(cm/s)² / cph
cph

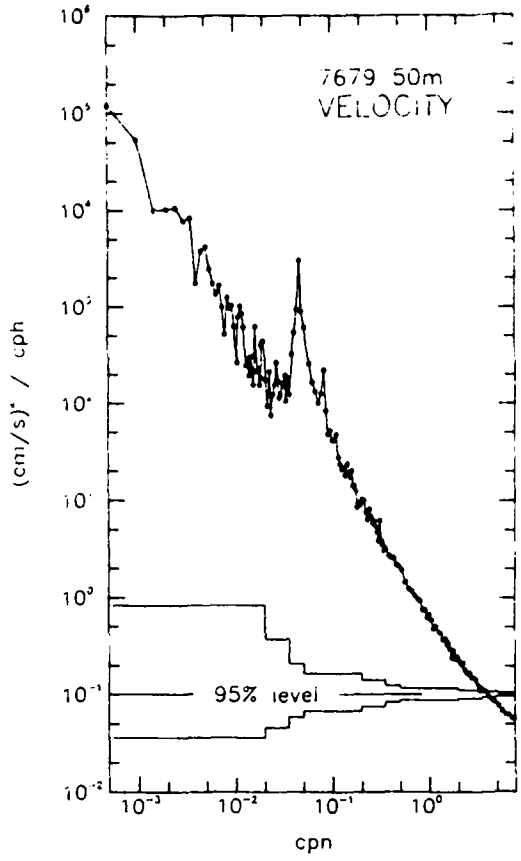

7706 25m
TEMPERATURE
95% level
(deg C)² / cph
cph

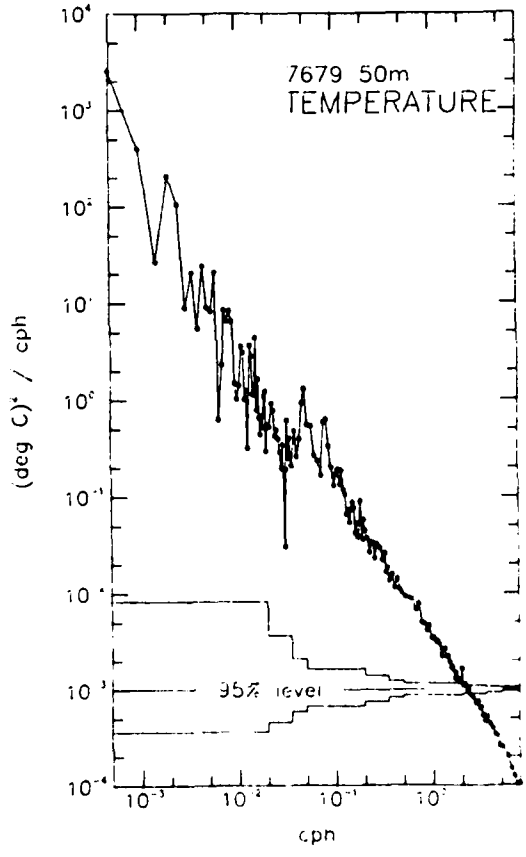

7678 35m
VELOCITY
95% level
CW SOLID CCW DASH
cpn

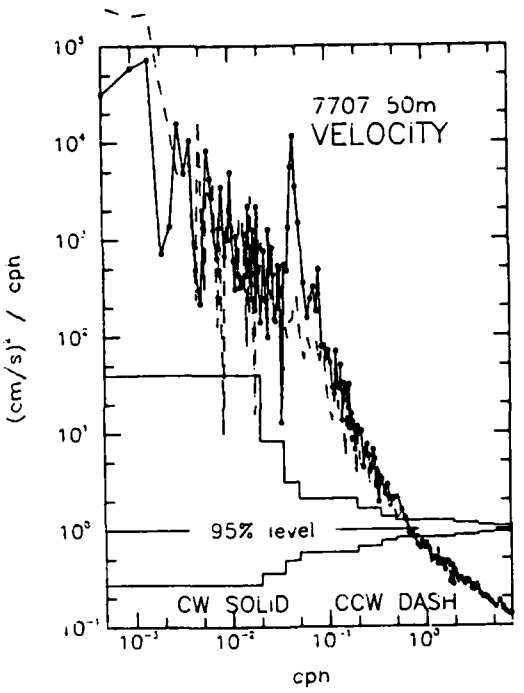

7678 35m
VELOCITY
95% level
cpn

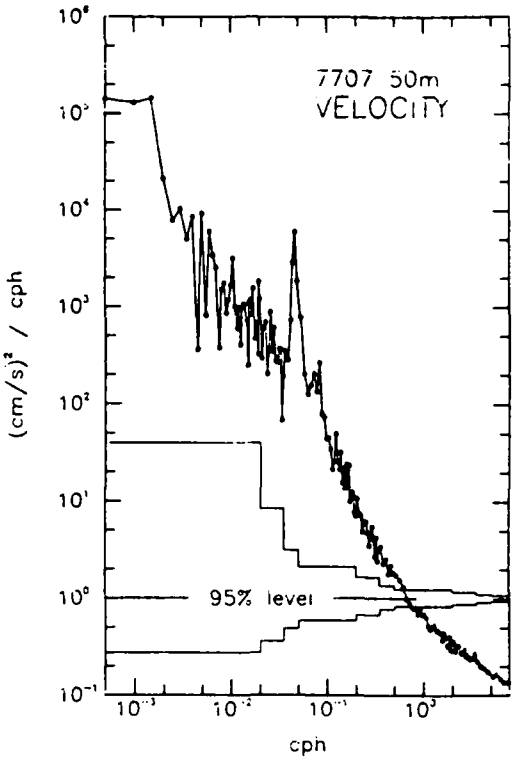

7678 35m
TEMPERATURE
95% level

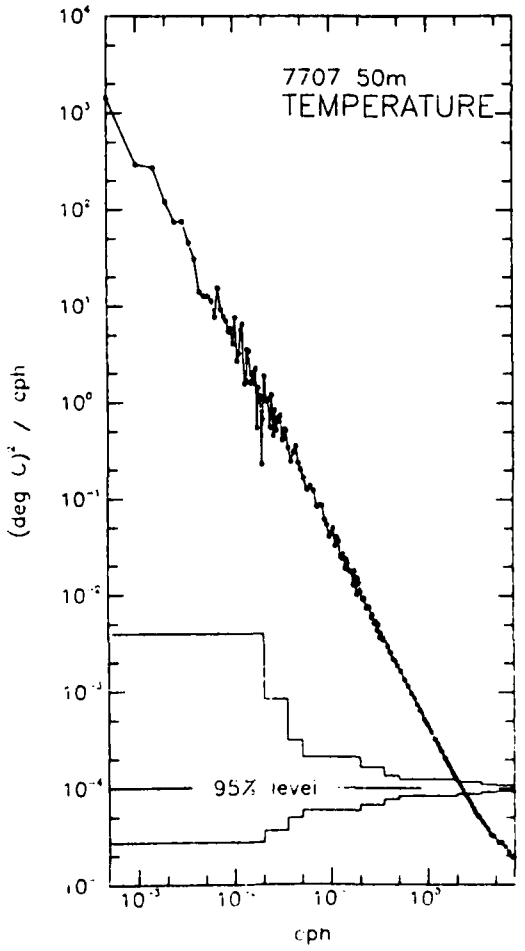

7679 50m
VELOCITY
95% level
CW SOLID CCW DASH
(cm/s)² / cph
cpn

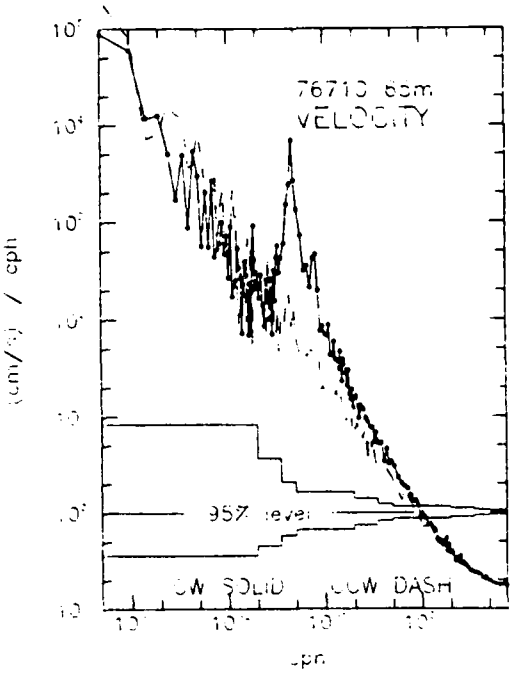

7679 50m
VELOCITY
95% level
(cm/s)² / cph
cpn

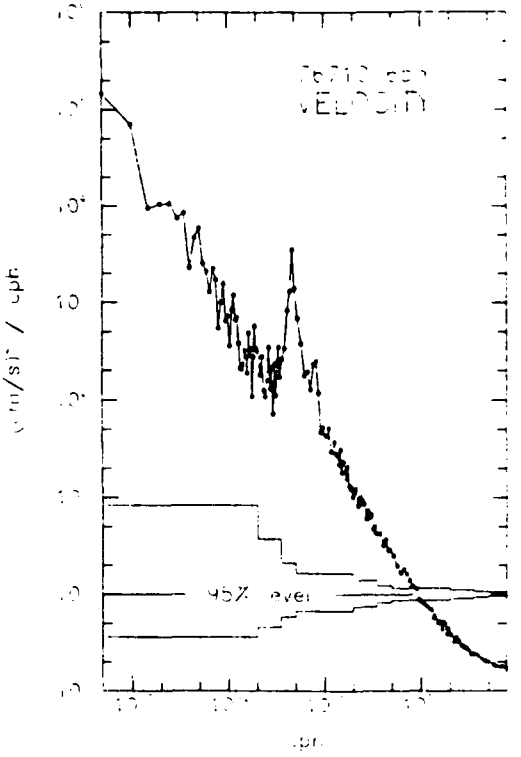

7679 50m
TEMPERATURE
95% level
(deg C)² / cph
cpn

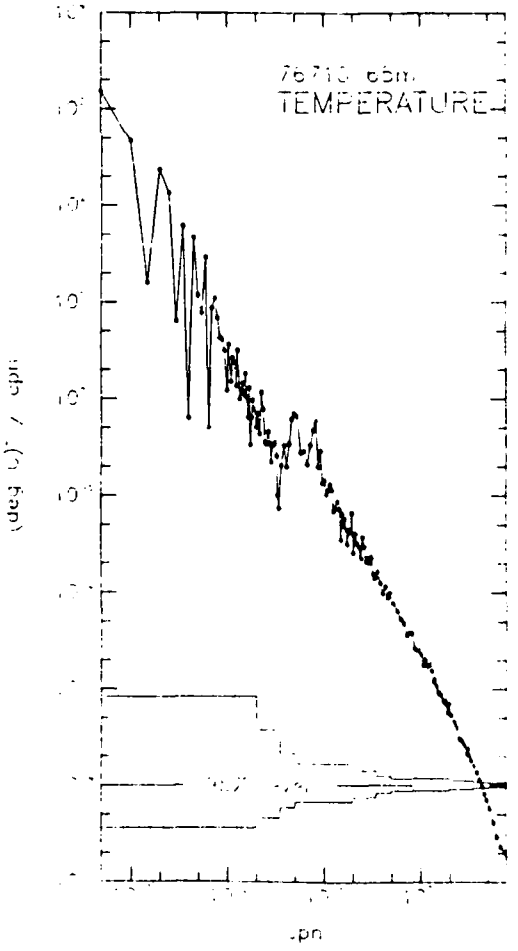

7707 50m
VELOCITY
95% level
CW SOLID CCW DASH
(cm/s)² / cpn
cpn

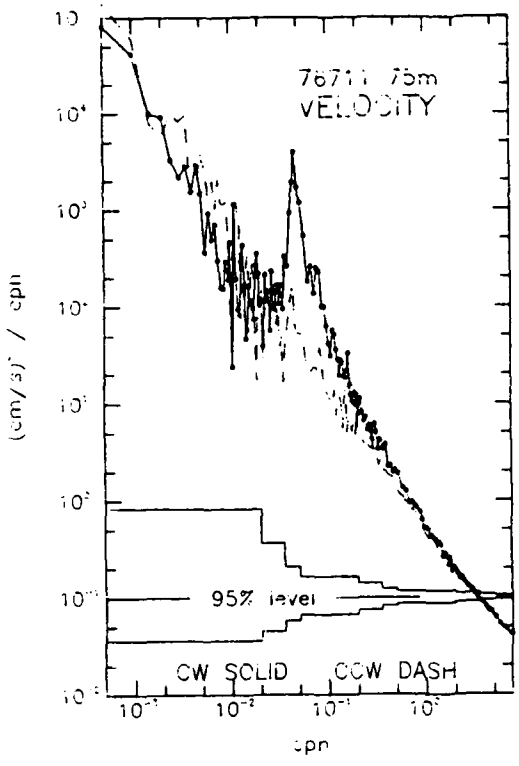

7707 50m
VELOCITY
95% level
(cm/s)² / cph
cph


7707 50m
TEMPERATURE
95% level
(deg C)² / cph
cph


76710 osm
VELOCITY
95% level
CW SOLID CCW DASH
cpn


76710 osm
VELOCITY
95% level
cpn


76710 osm
TEMPERATURE
cpn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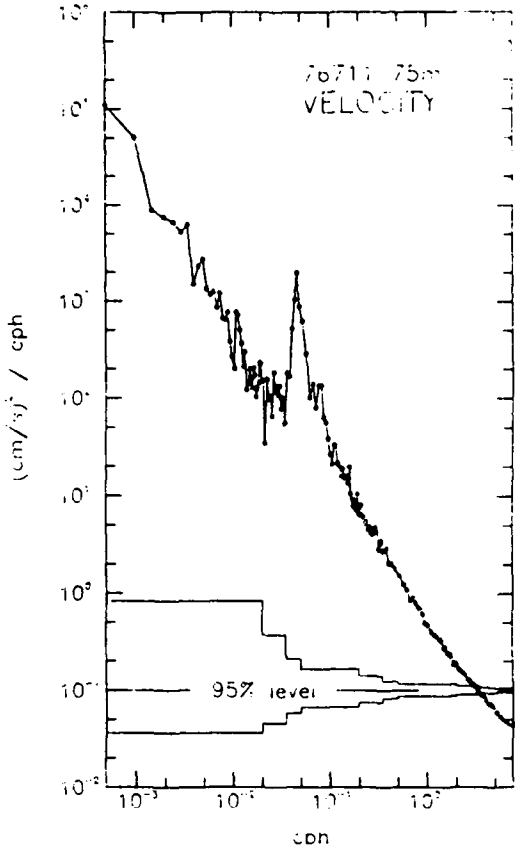
CW SOLID CCW DASH
cpn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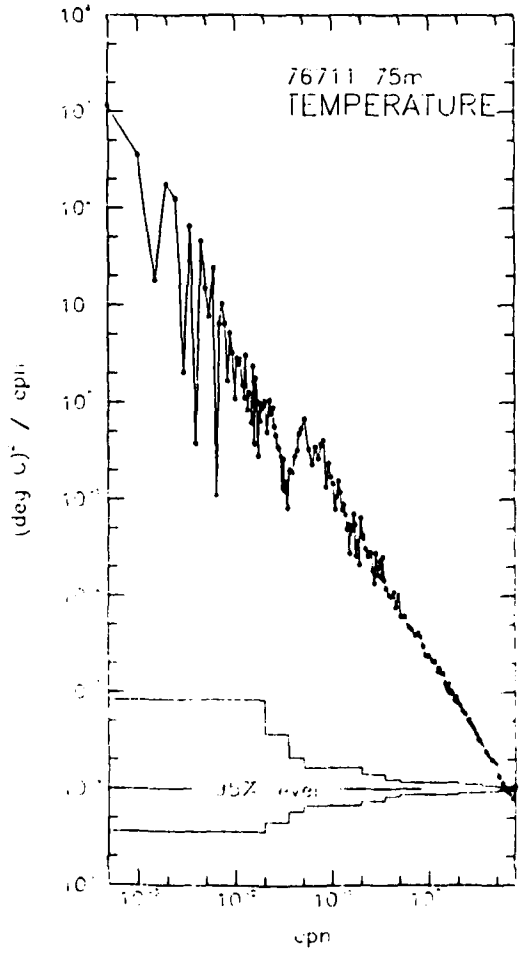
cpn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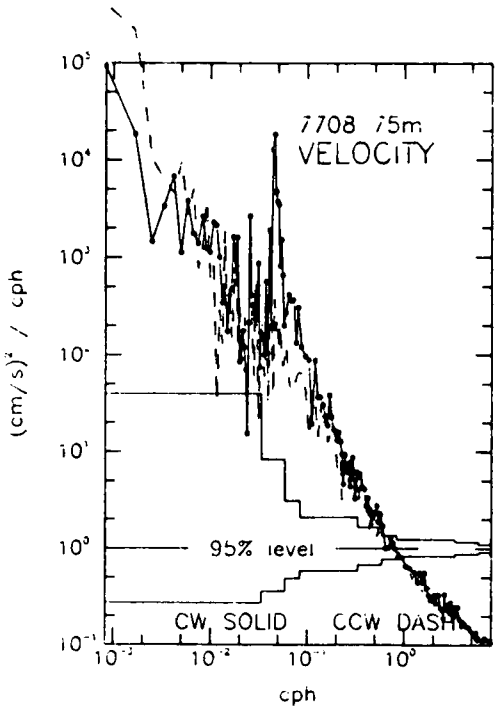
TEMPERATURE
cpn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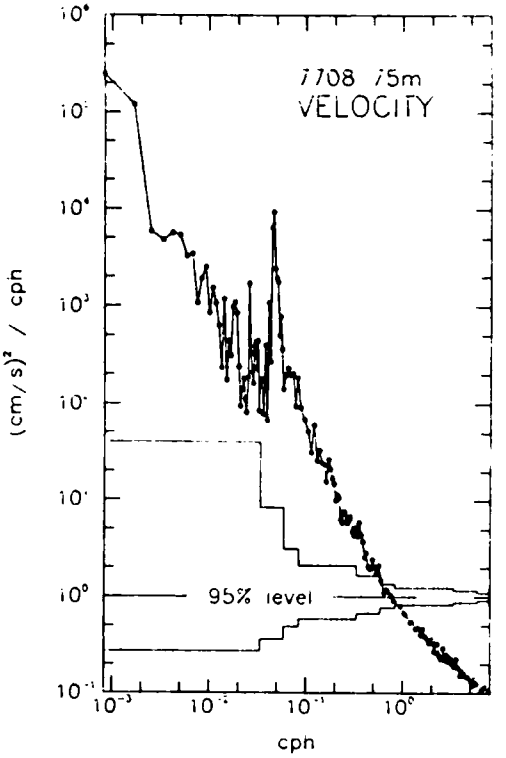
(cm/s)² / cph
cph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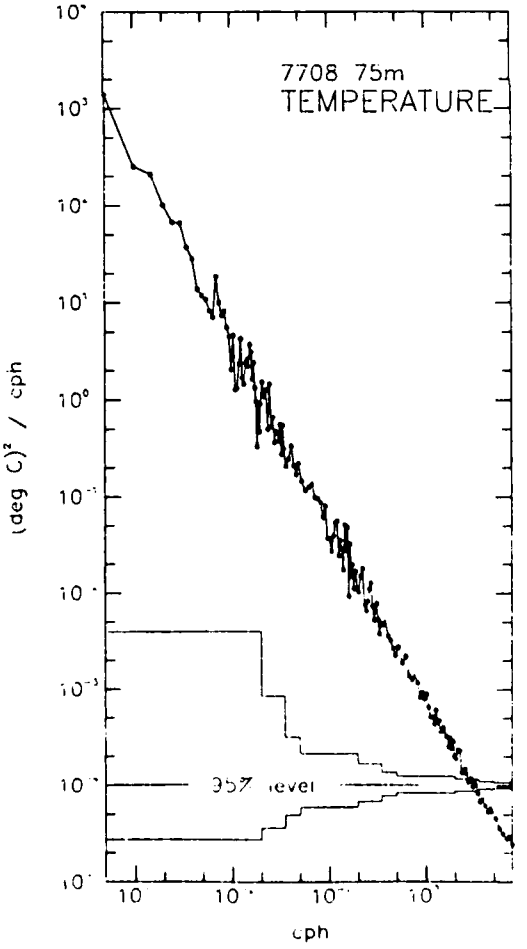
(cm/s)² / cph
cph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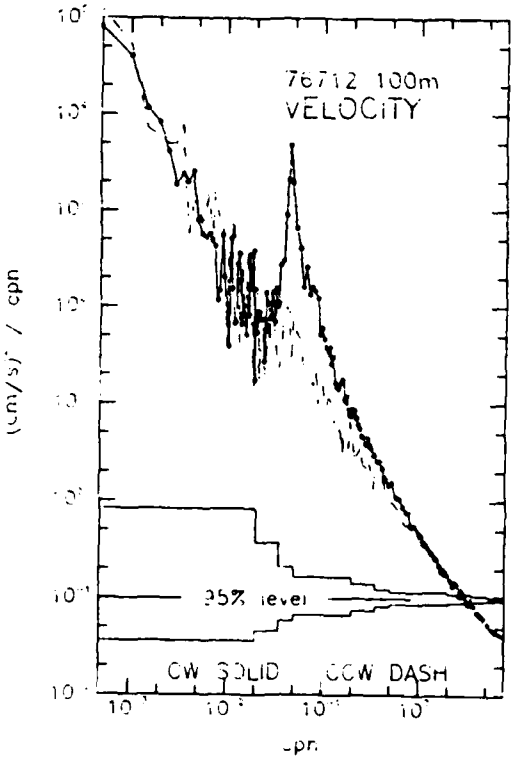
TEMPERATURE
95% level
(deg C)² / cph
cph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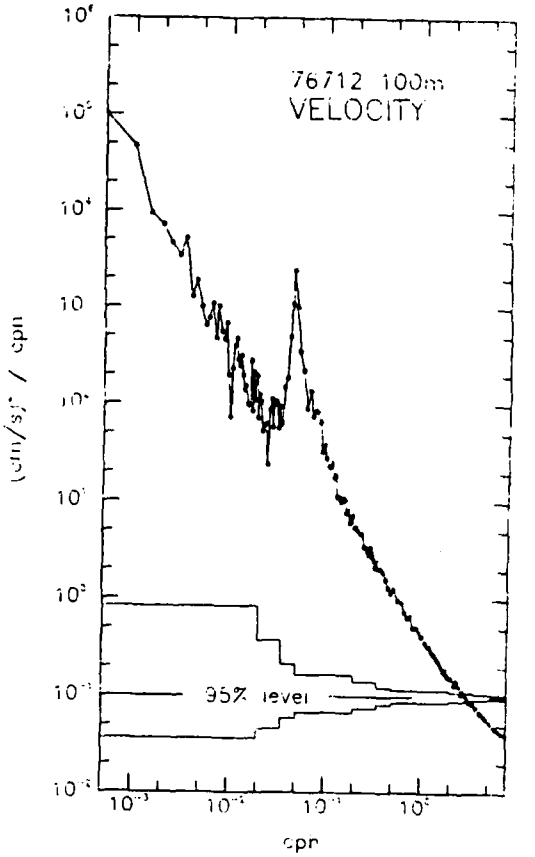
cpn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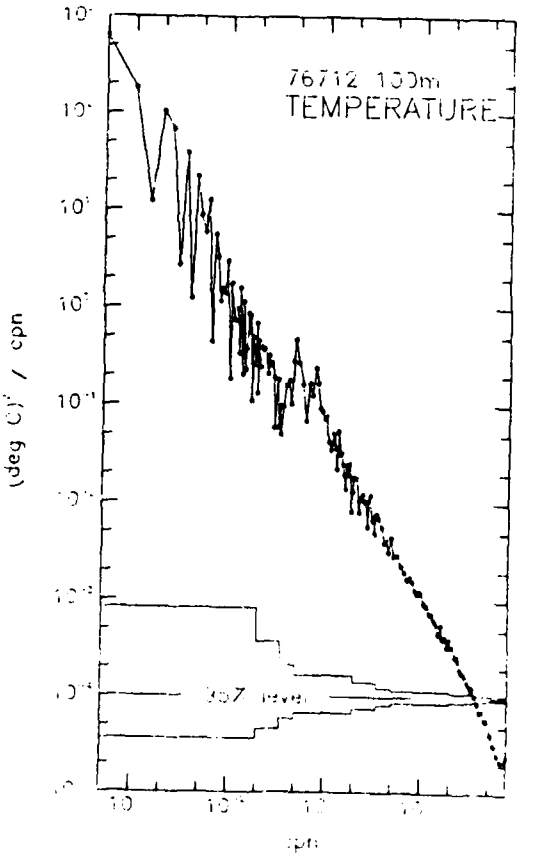
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TEMPERATURE
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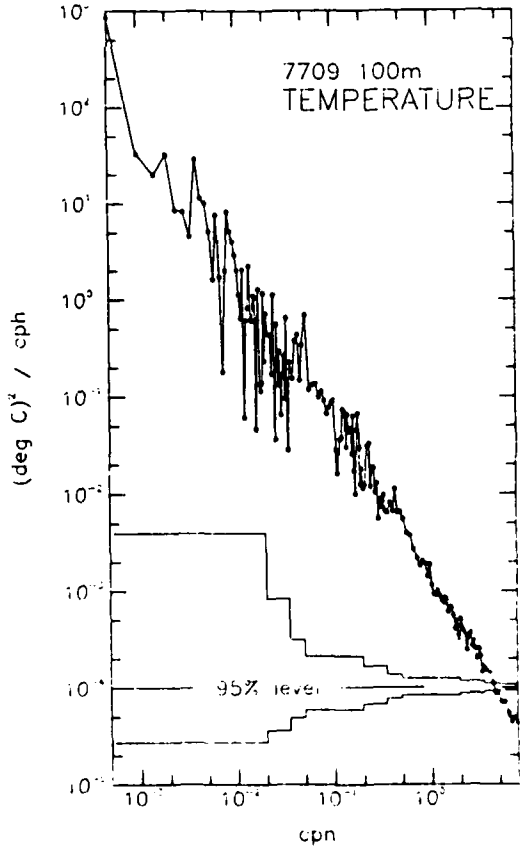
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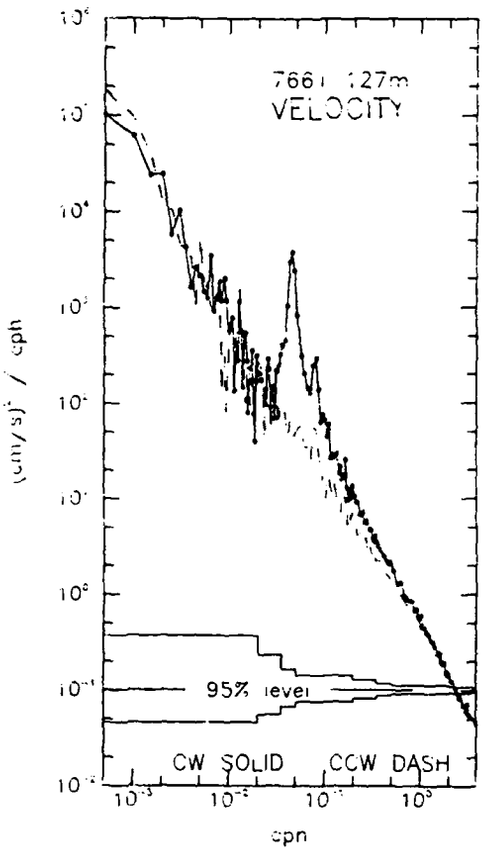
TEMPERATURE
(deg C)² / cph
95% level
cpn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CW SOLID CCW DASH
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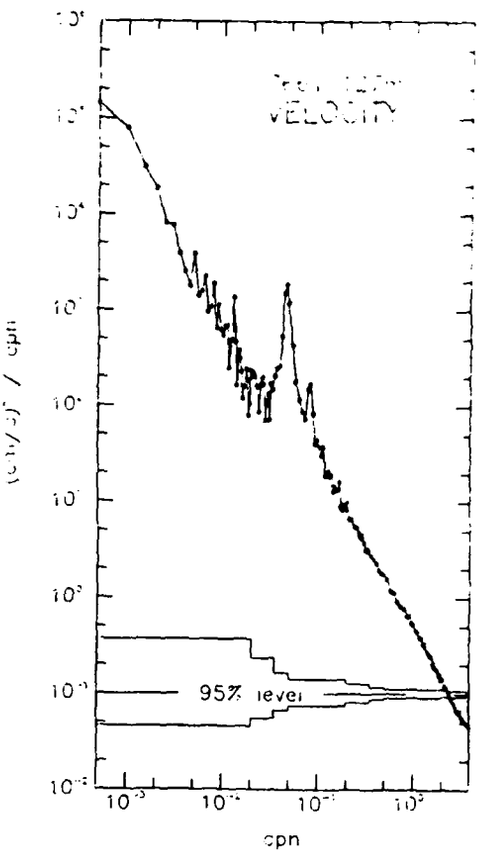
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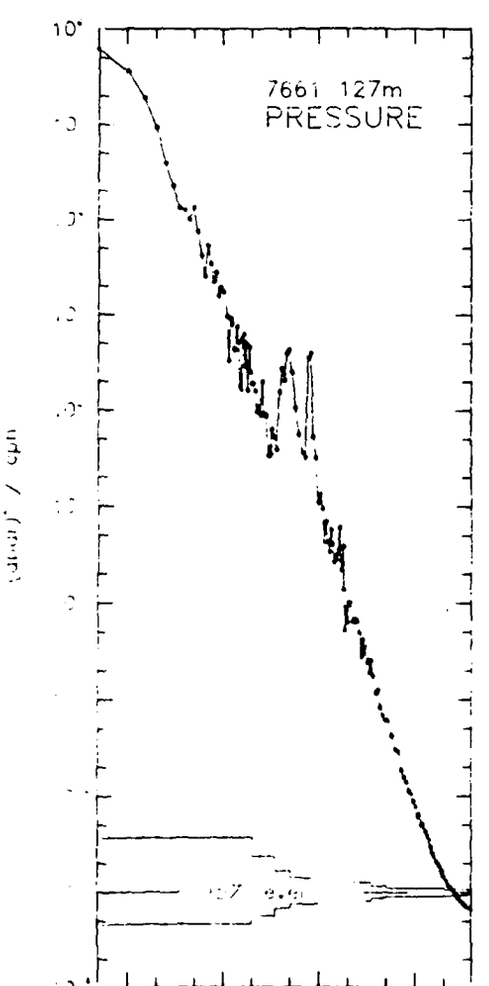
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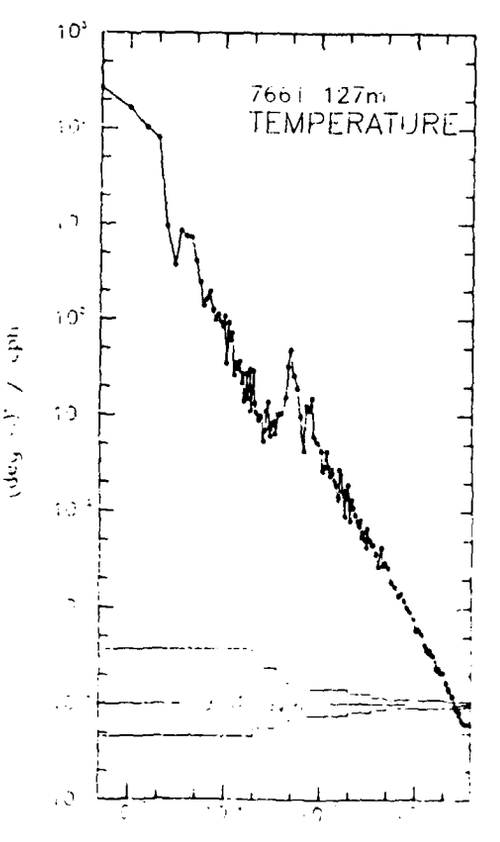
PRESSURE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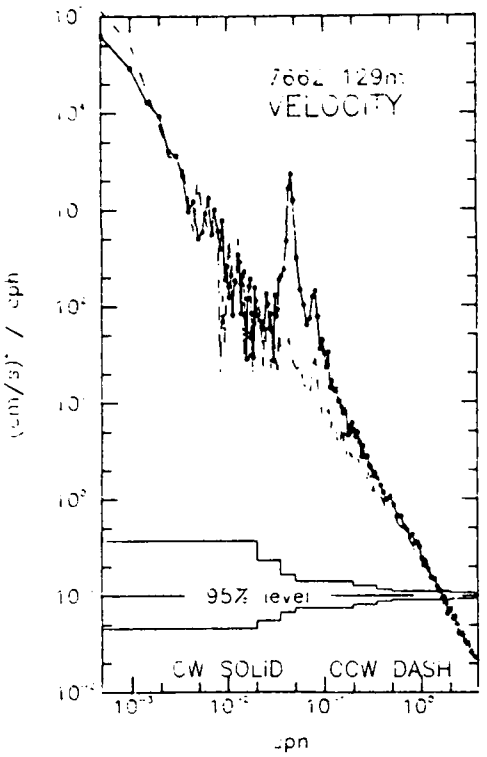
TEMPERATURE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VELOCITY
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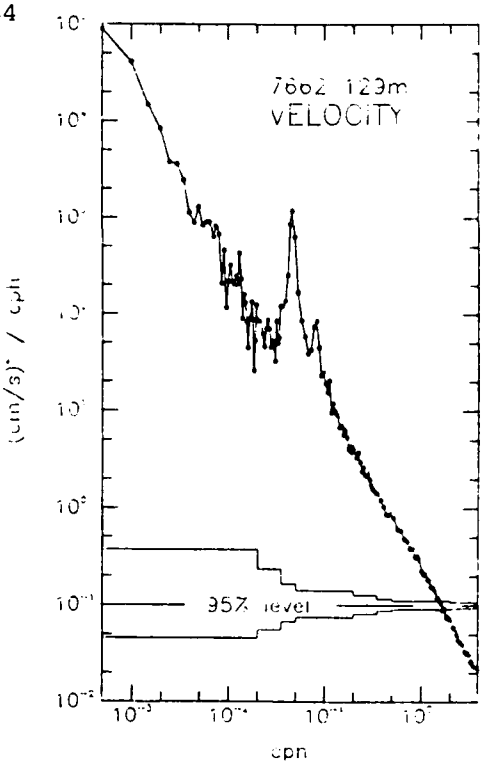
CW SOLID CCW DASH
cpn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VELOCITY
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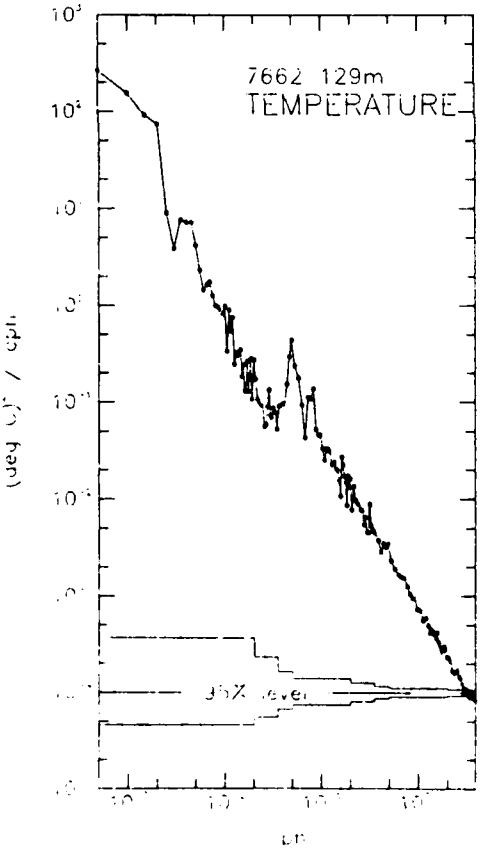
cpn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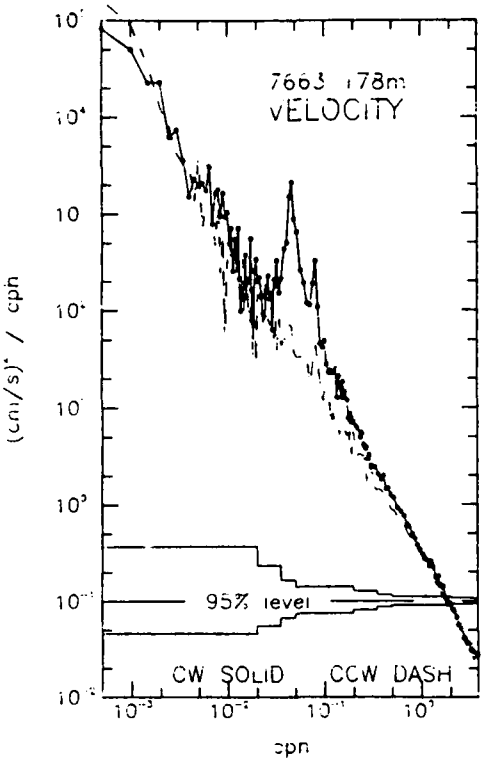
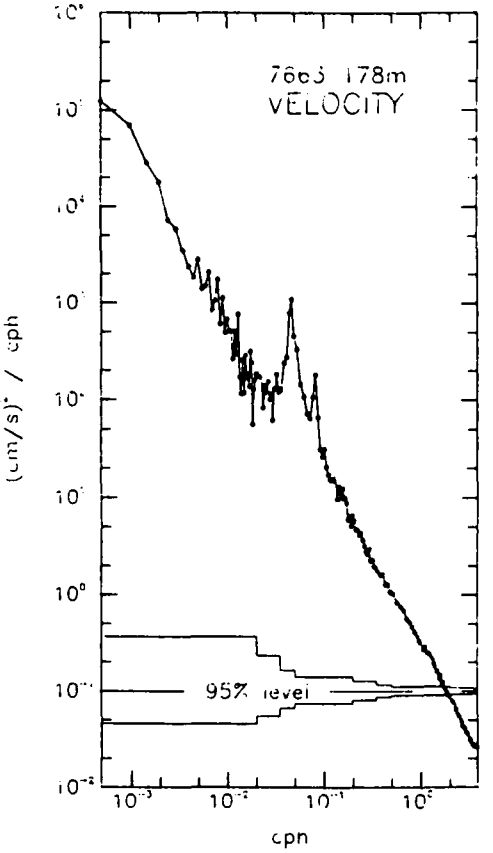
TEMPERATURE
95% level
cpn


7663 178m
VELOCITY
95% level
CW SOLID CCW DASH
(cm/s)² / cph
cpn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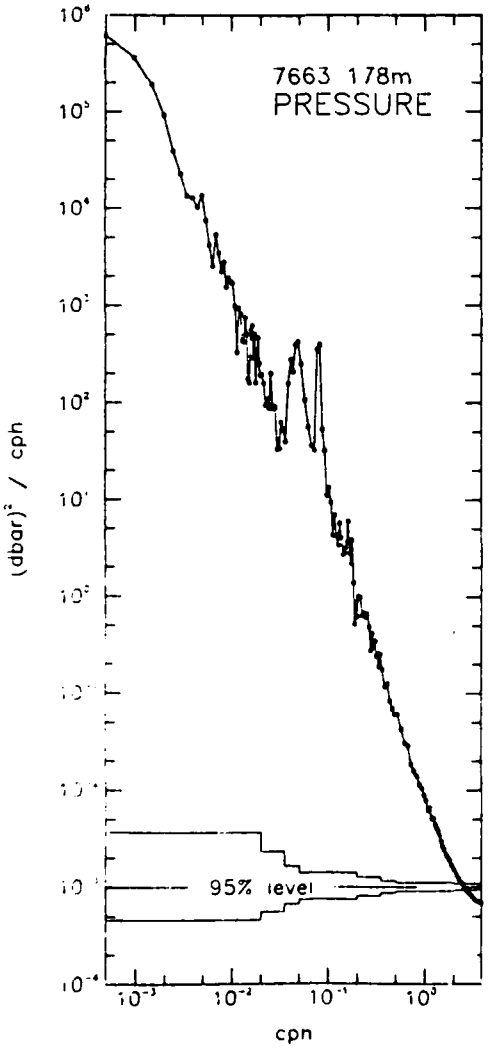
VELOCITY
95% level
(cm/s)² / cph
cpn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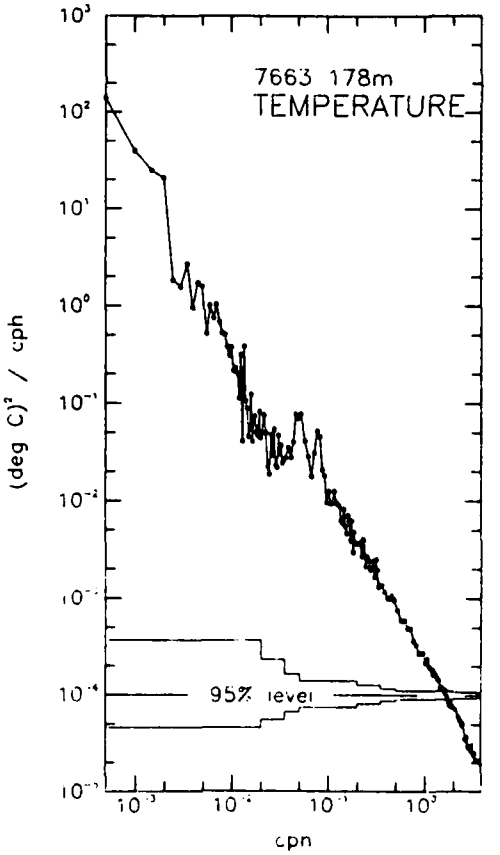
PRESSURE
95% level
(dbar)² / cph
cpn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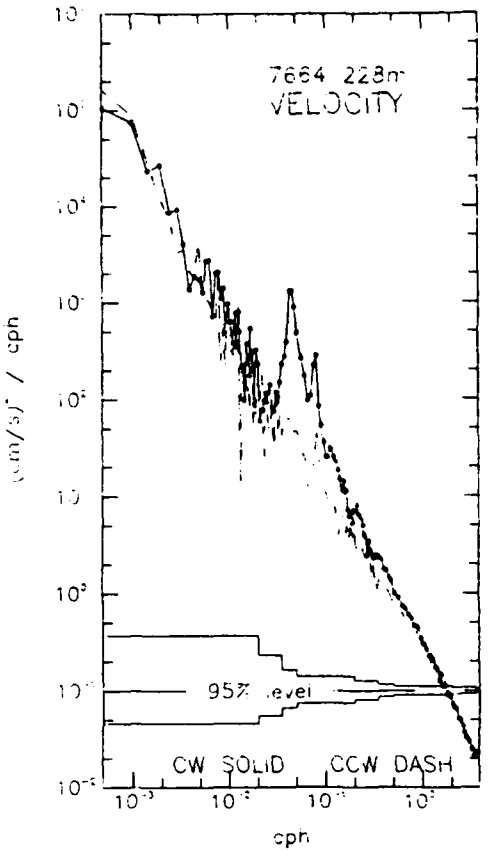
TEMPERATURE
95% level
(deg C)² / cph
cpn


7664 228m
VELOCITY
95% level
CW SOLID CCW DASH
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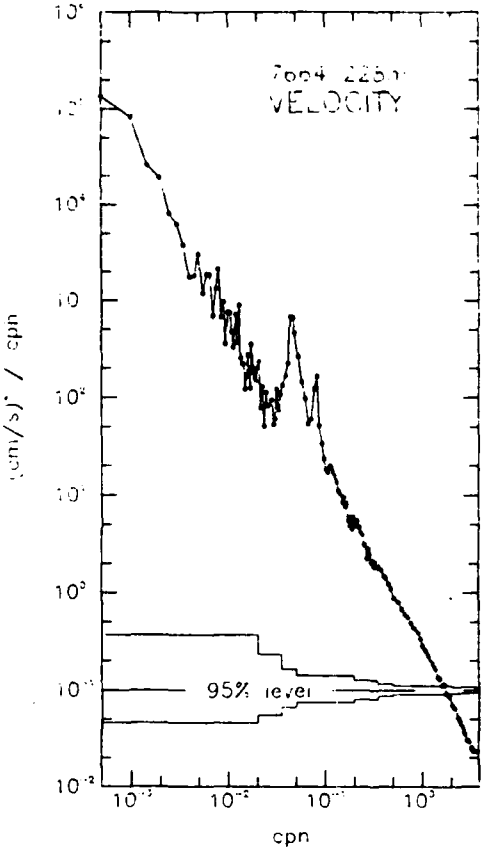
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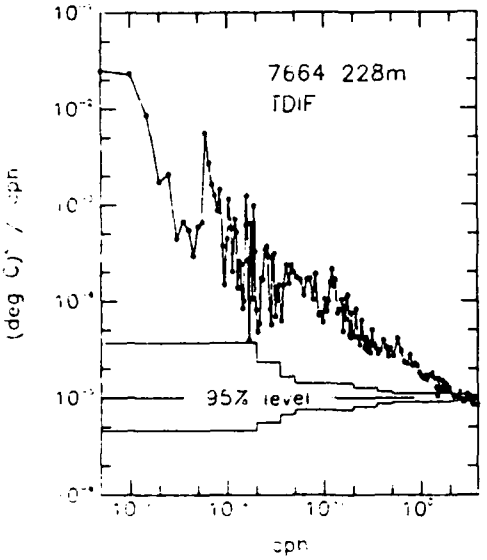
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TDIF
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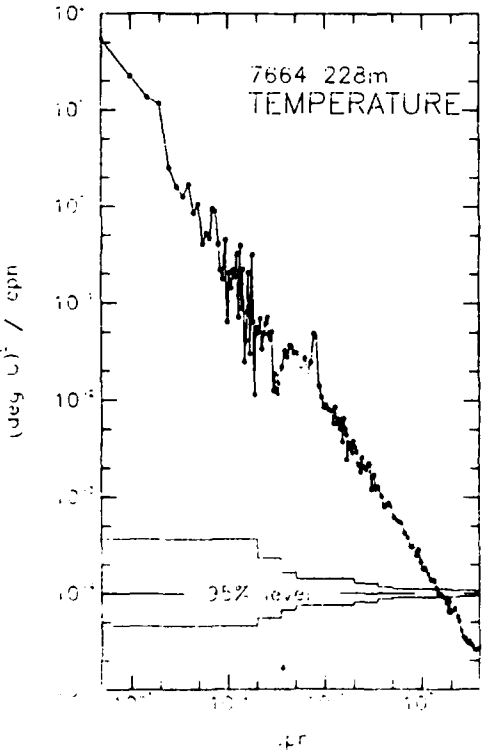
cpn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TEMPERATURE
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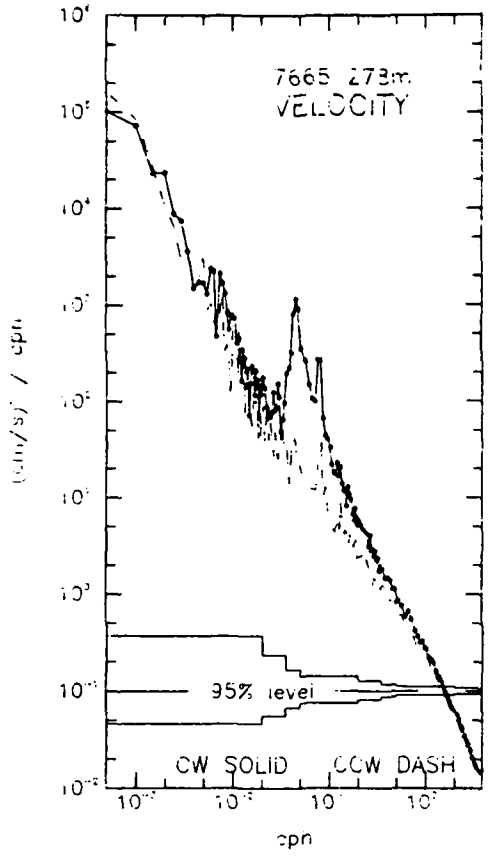
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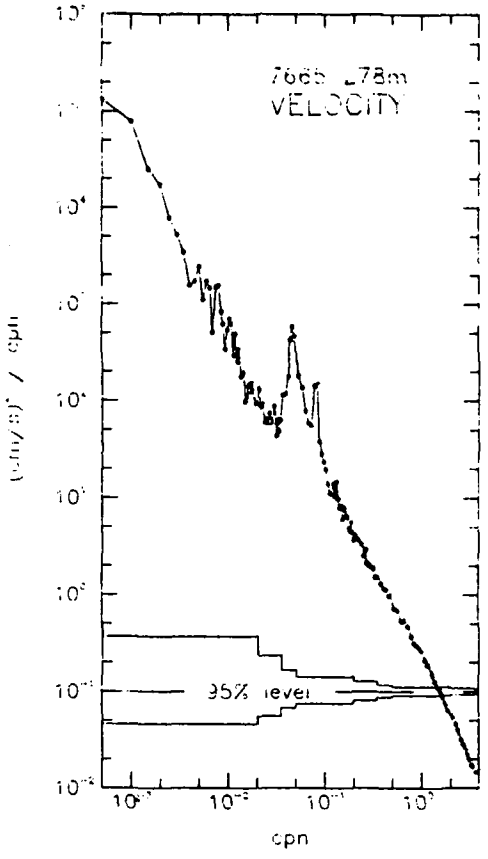
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VELOCITY
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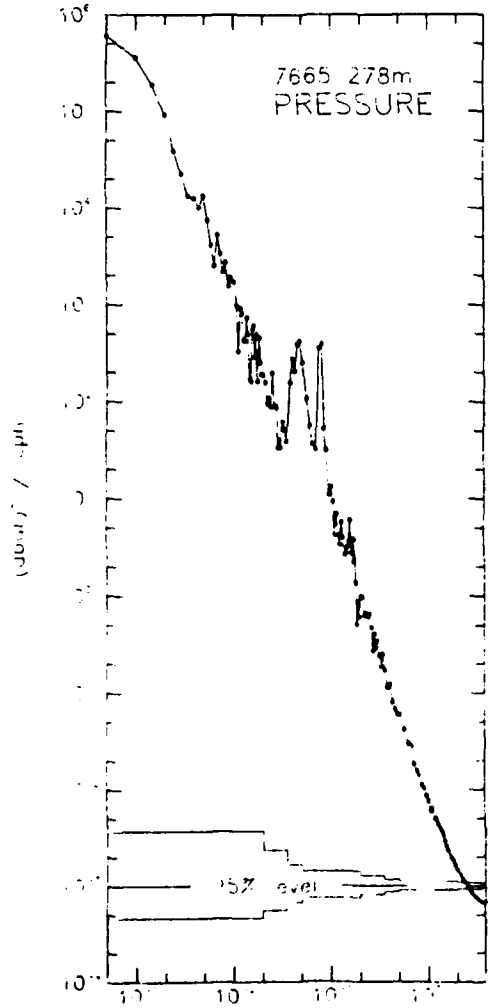
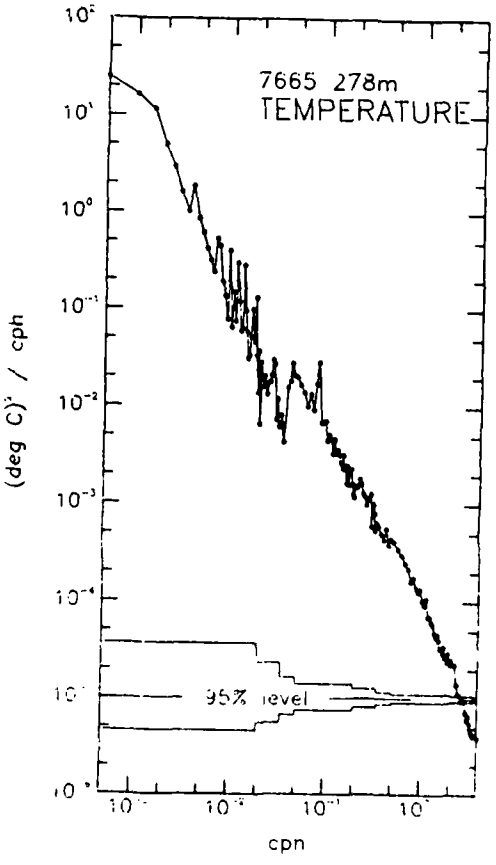
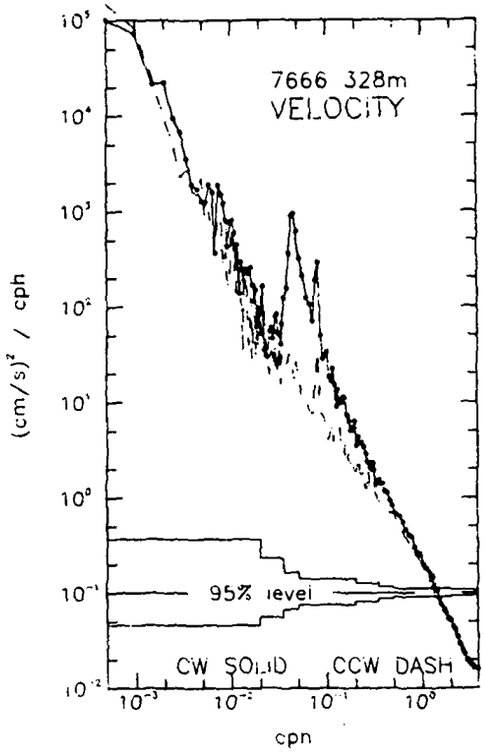
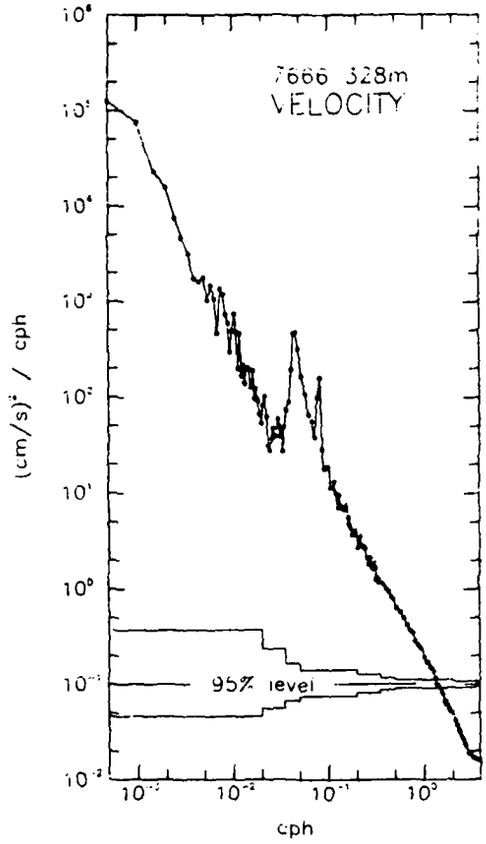
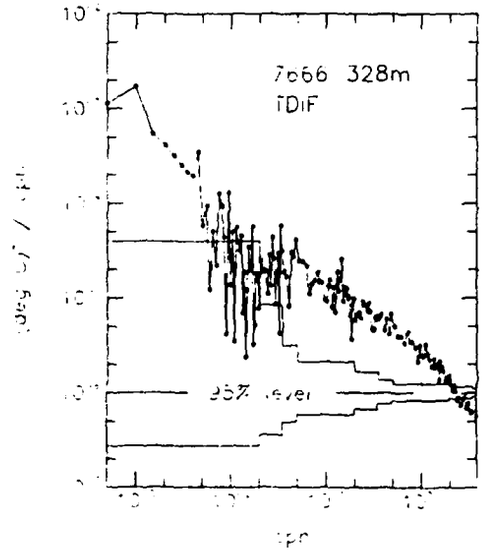

7665 278m
PRESSURE
95% level


7665 278m
TEMPERATURE
(deg C)² / cph
95% level
cpn


7666 328m
VELOCITY
95% level
CW SOLID CCW DASH
(cm/s)² / cph
cpn


7666 328m
VELOCITY
95% level
(cm/s)² / cph
cph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TDIF
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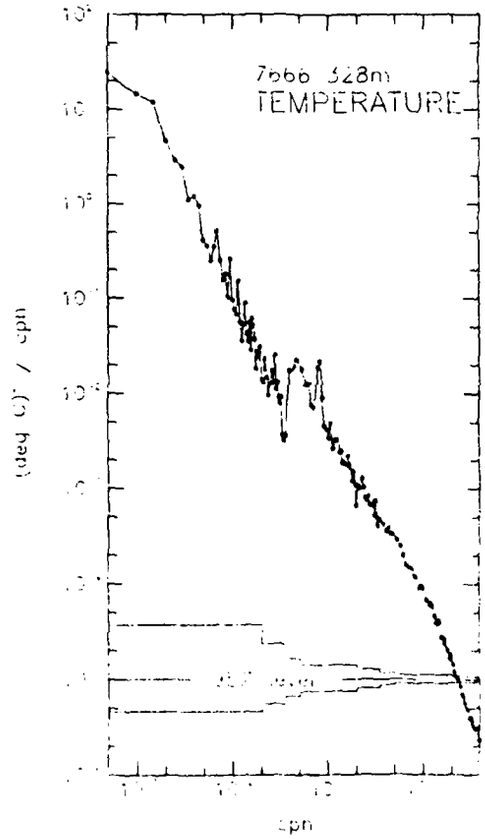
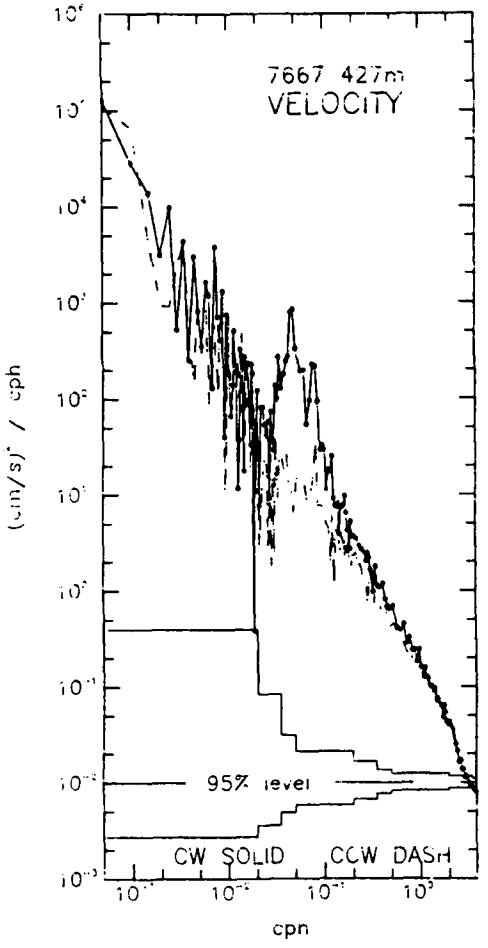
cpn


7666 328m
TEMPERATURE
(deg C)² / cph
cph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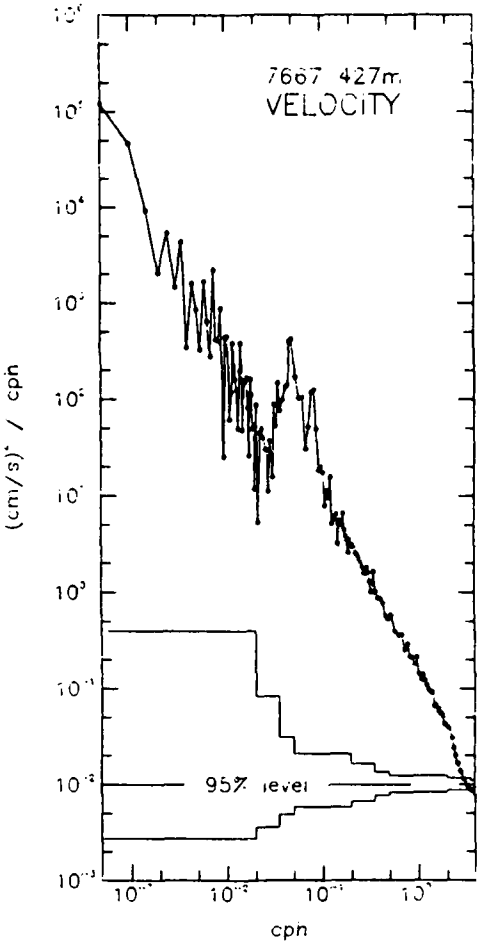
VELOCITY
95% level
CW SOLID CCW DASH
(cm/s)² / cph
cpn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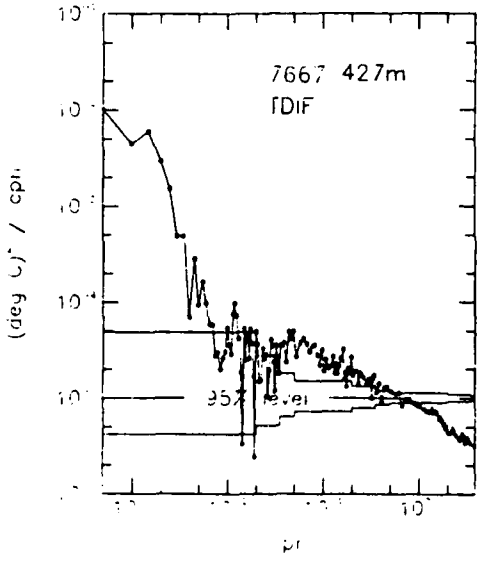
VELOCITY
95% level
(cm/s)² / cph
cpn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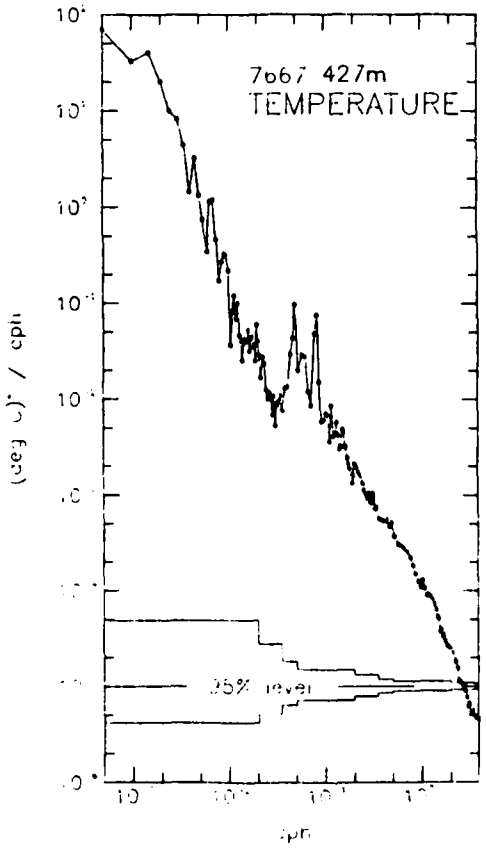
TDIF
95% level
(deg C)² / cph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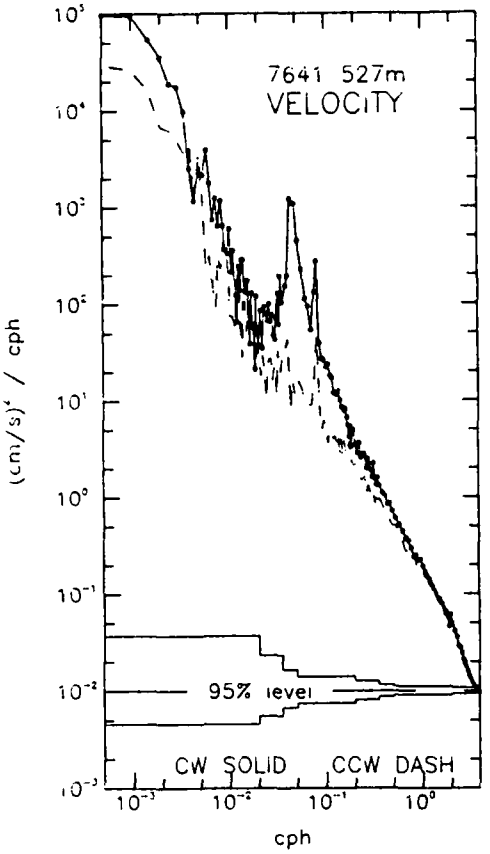
TEMPERATURE
95% level
(deg C)² / cph
cpn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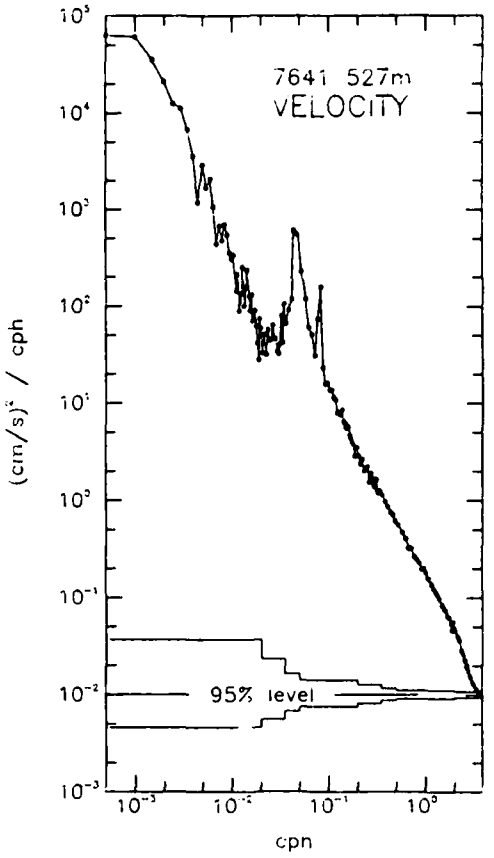
VELOCITY
95% level
CW SOLID CCW DASH
(cm/s)² / cph
cph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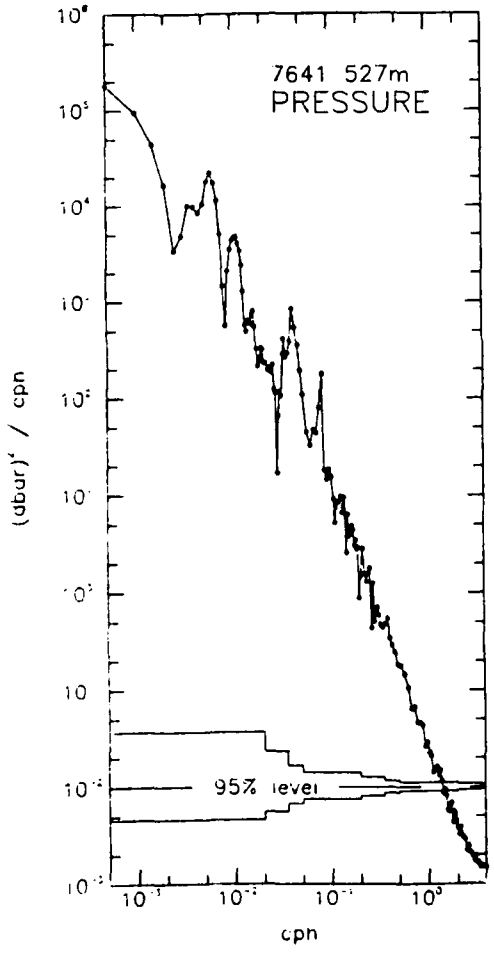
95% level
(cm/s)² / cph
cpn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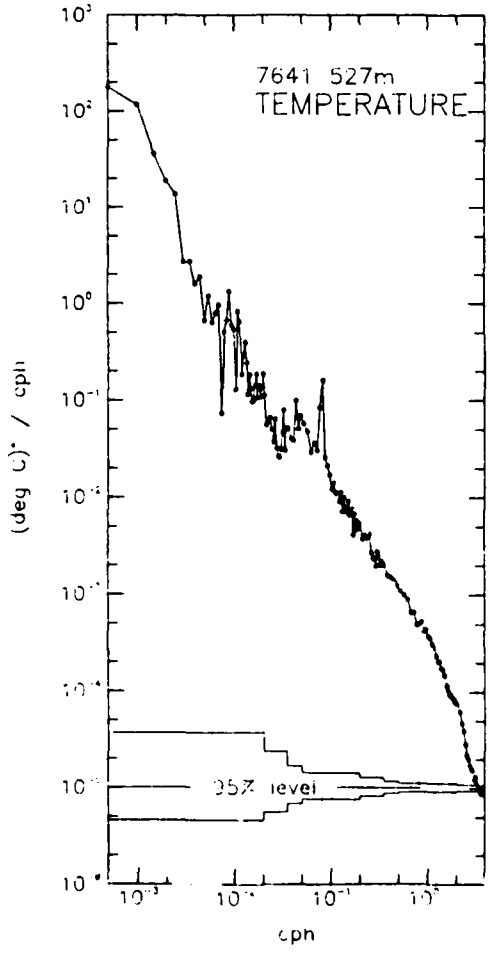
PRESSURE
95% level
(dbar)² / cpn
cpn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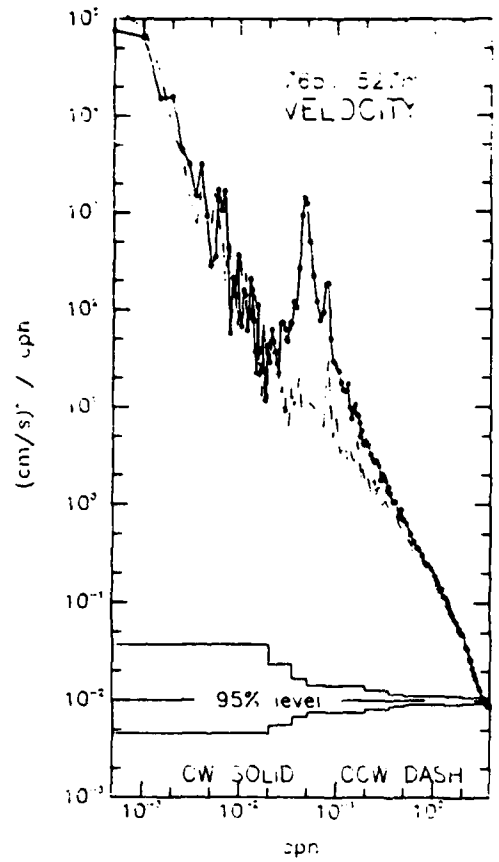
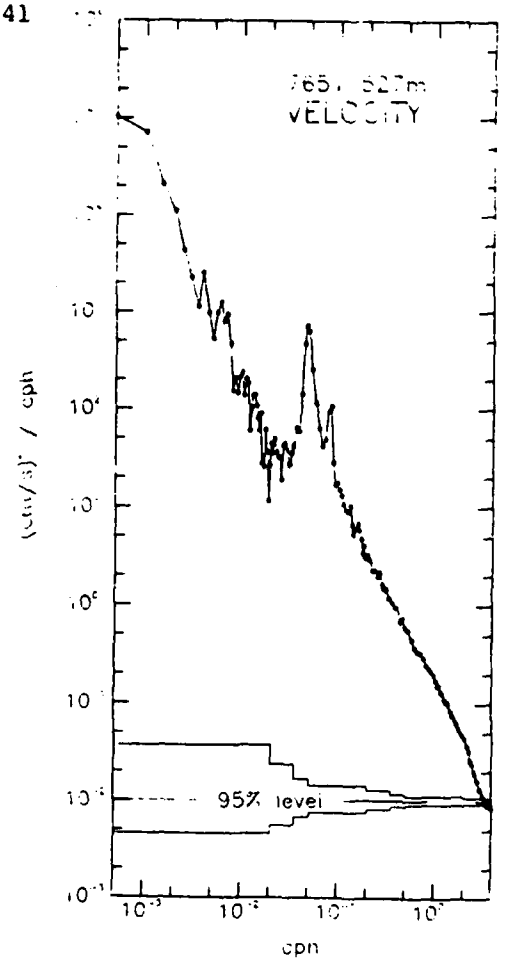
TEMPERATURE
95% level
(deg C)² / cph
cpn


765, 527m
VELOCITY
(cm/s)² / cph
95% level
CW SOLID CCW DASH
cph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VELOCITY
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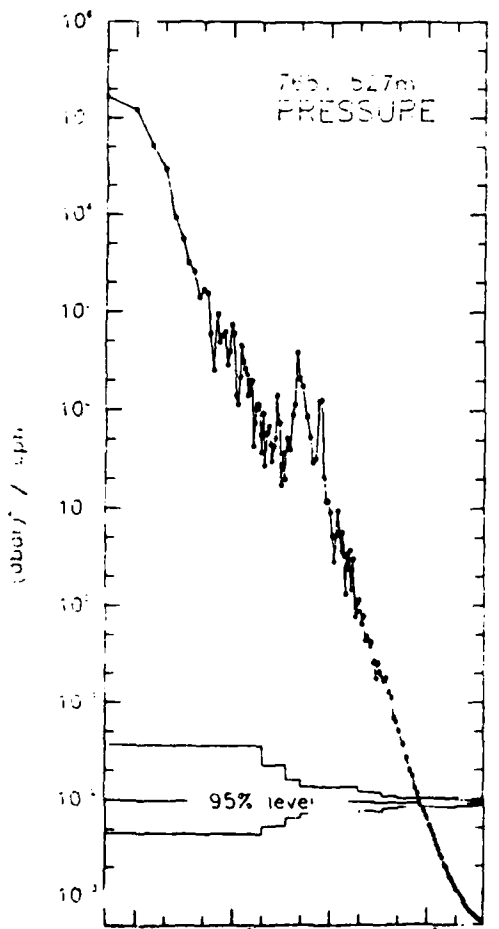
765, 527m
PRESSURE
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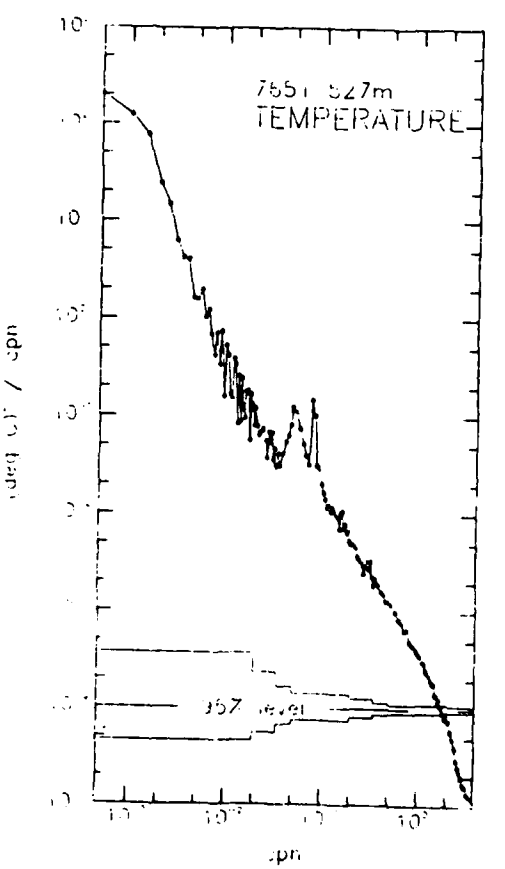
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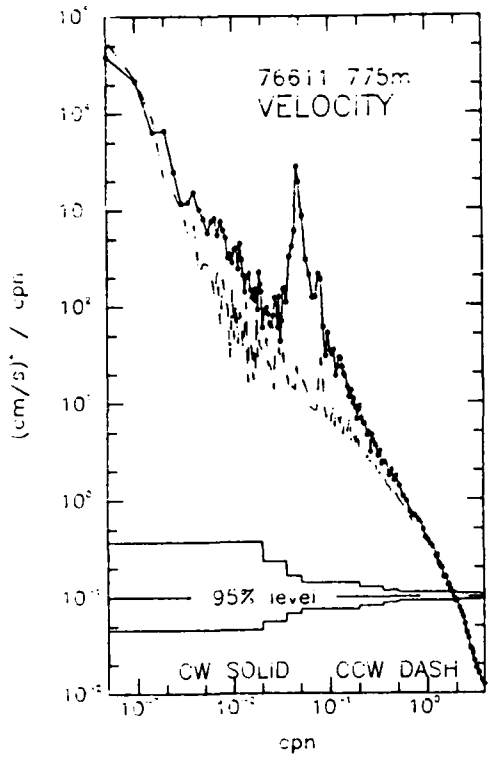
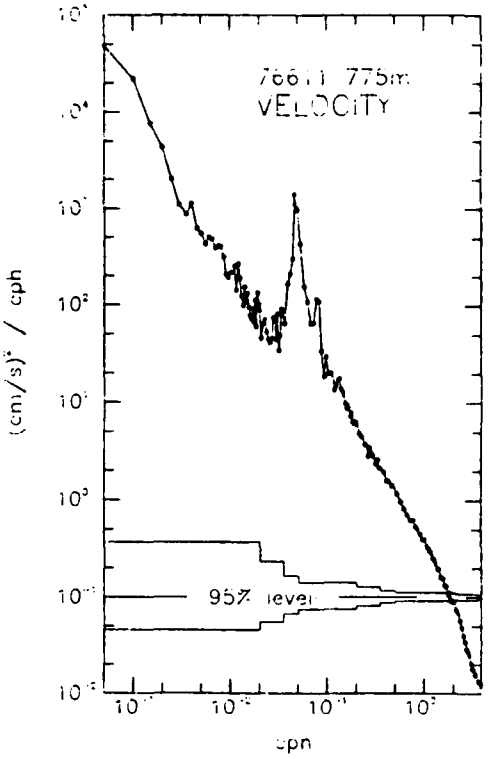
TEMPERATURE
cph


76611 775m
VELOCITY
95% level
CW SOLID CCW DASH
cpn


76611 775m
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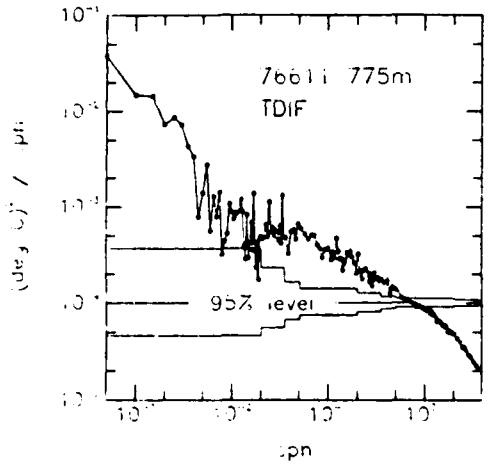
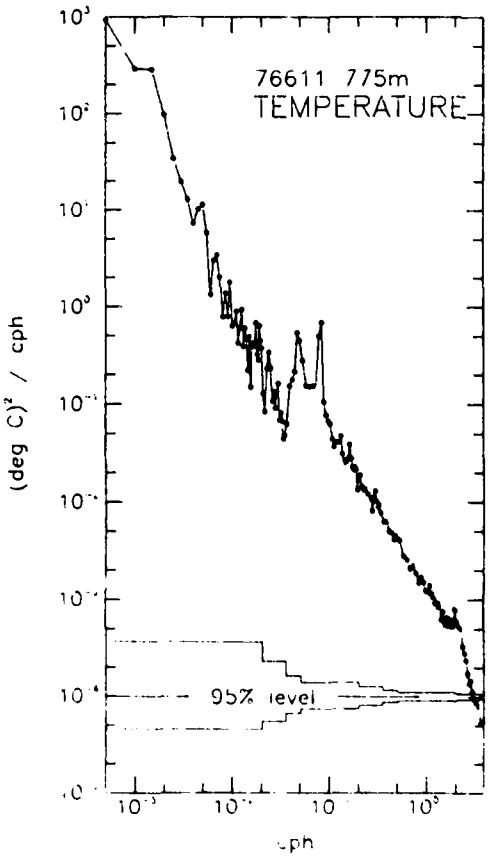
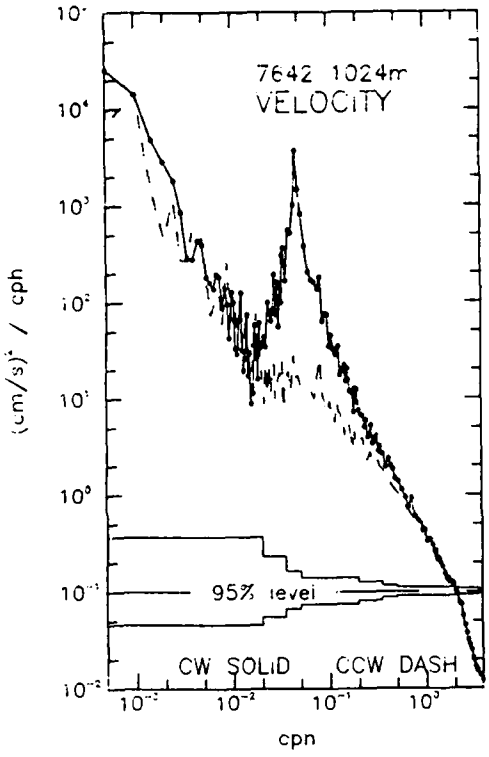

76611 775m
TDIF
95% level
cpn


76611 775m
TEMPERATURE
95% level
(deg C)² / cph
cph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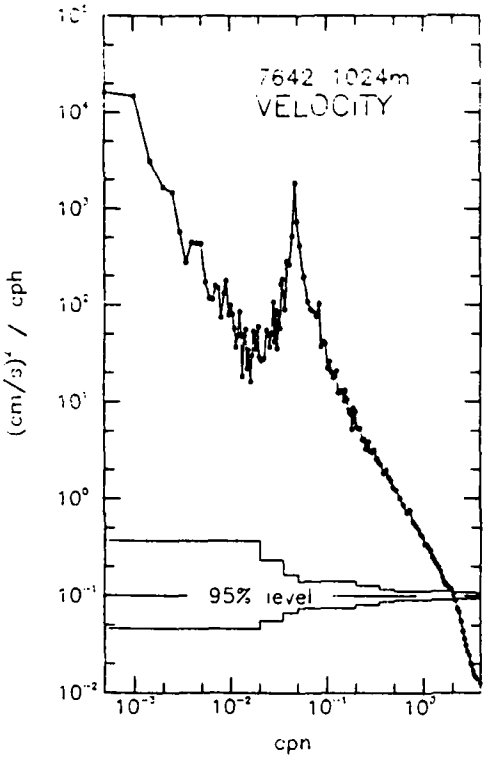
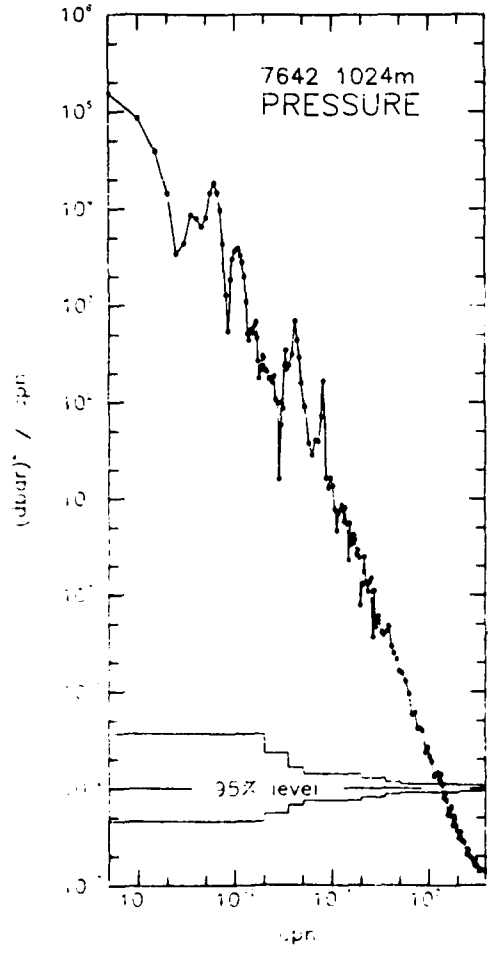
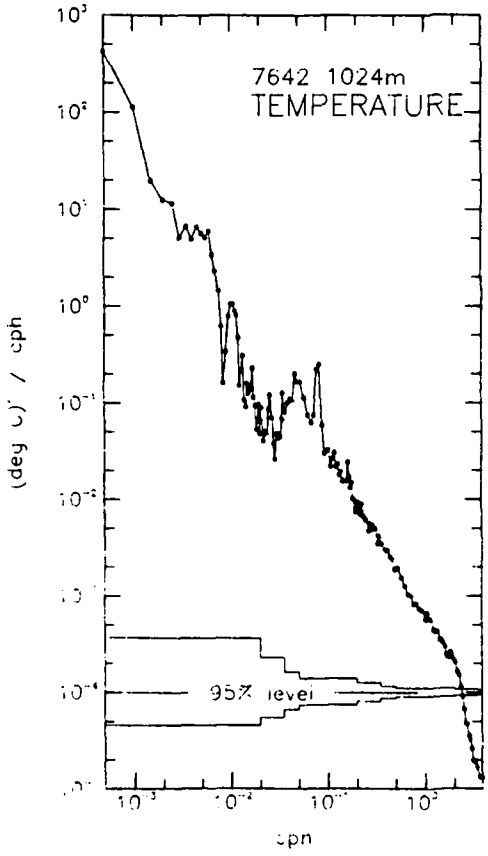
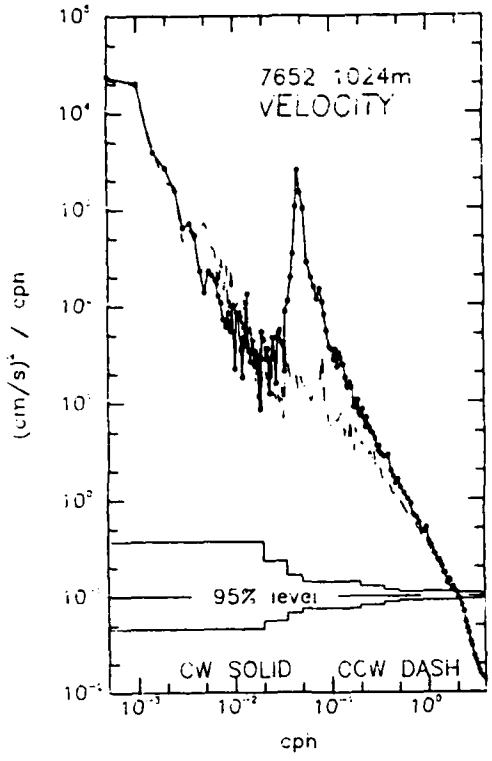
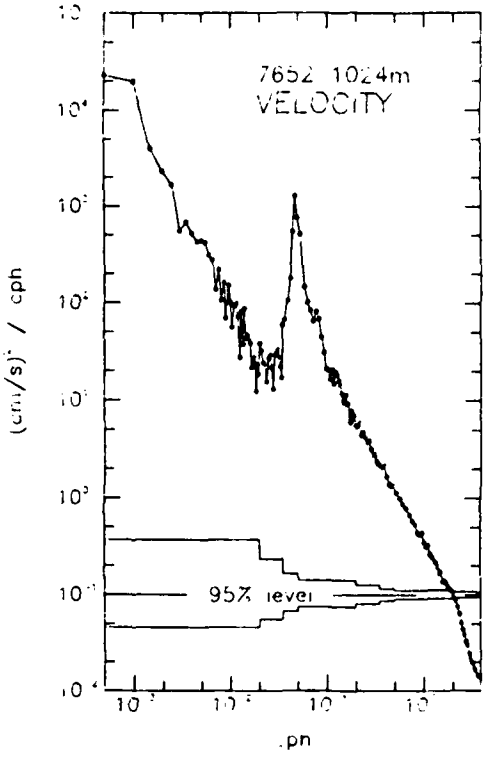
VELOCITY
95% level
CW SOLID CCW DASH
(cm/s)² / cph
cpn

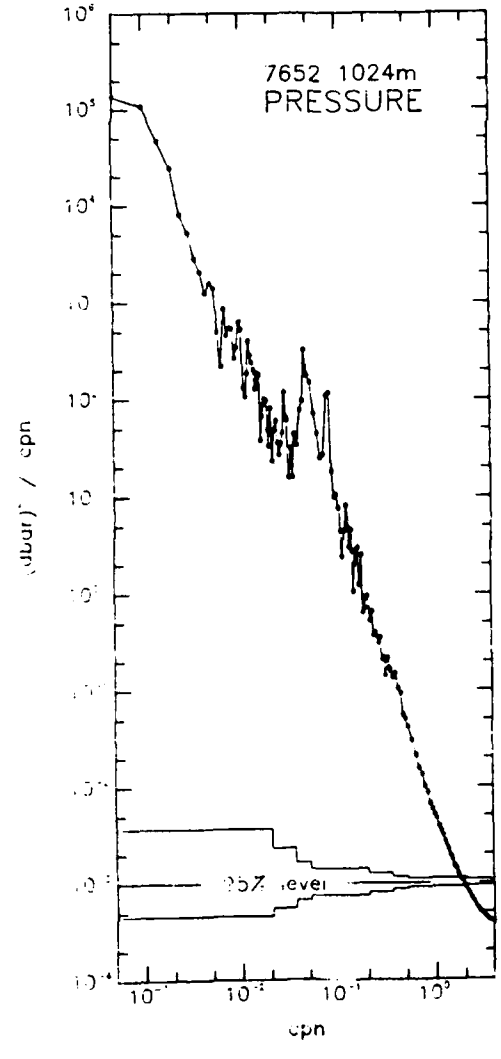

7642 1024m
VELOCITY
95% level
(cm/s)² / cph
cpn

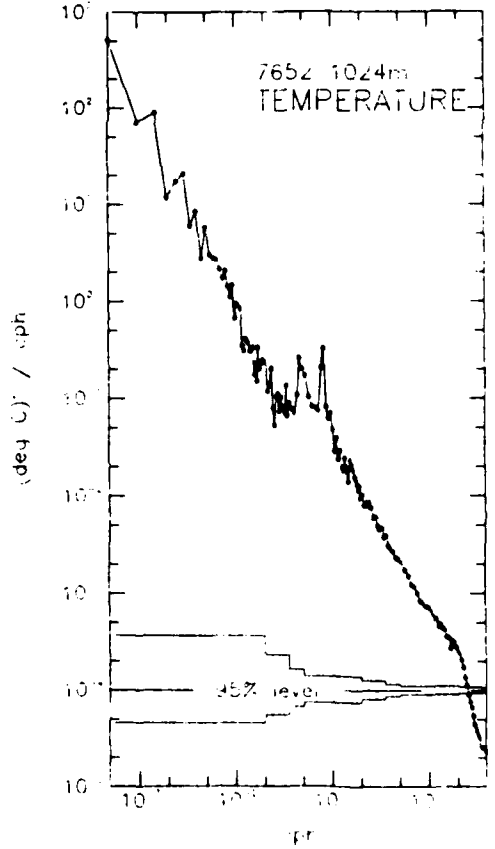

7642 1024m
PRESSURE
95% level
cpn

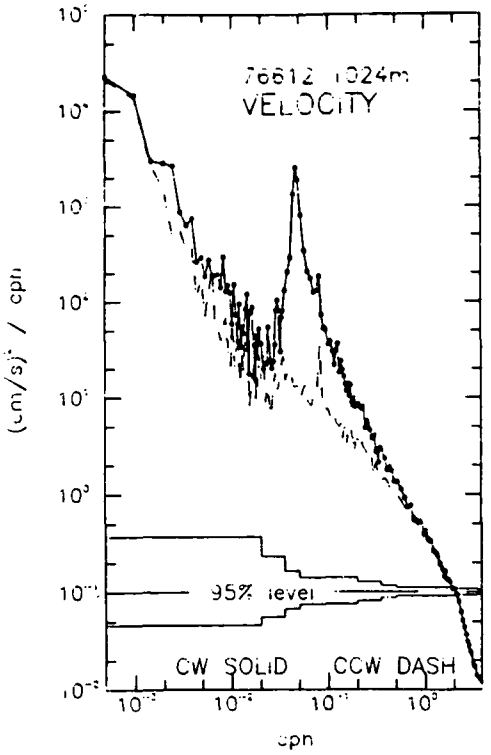

7642 1024m
TEMPERATURE
95% level
(deg C)² / cph
cpn

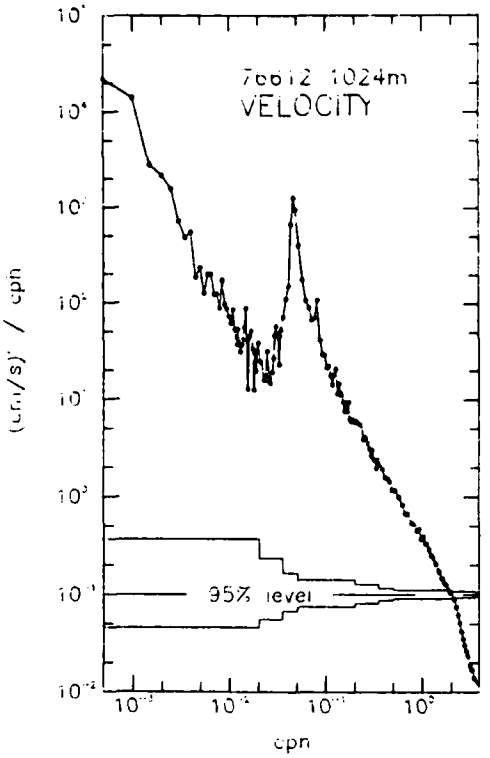

7652 1024m
VELOCITY
95% level
CW SOLID CCW DASH
(cm/s)² / cpn
cpn

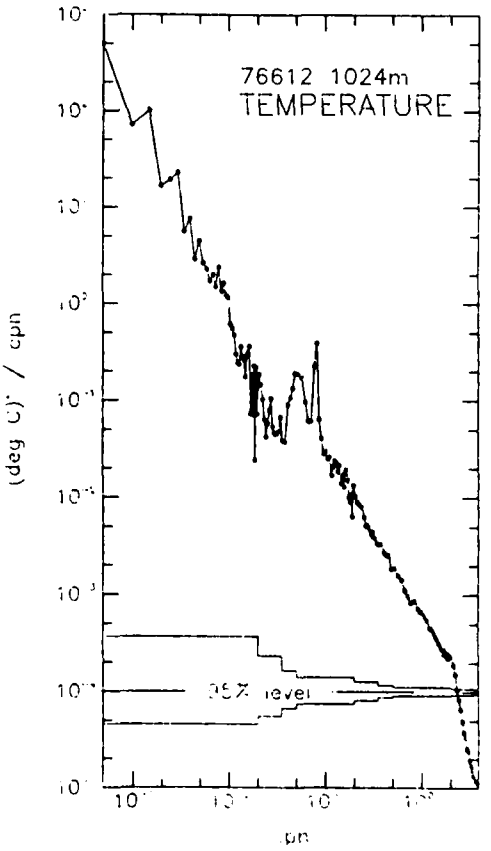

7652 1024m
VELOCITY
95% level
cpn

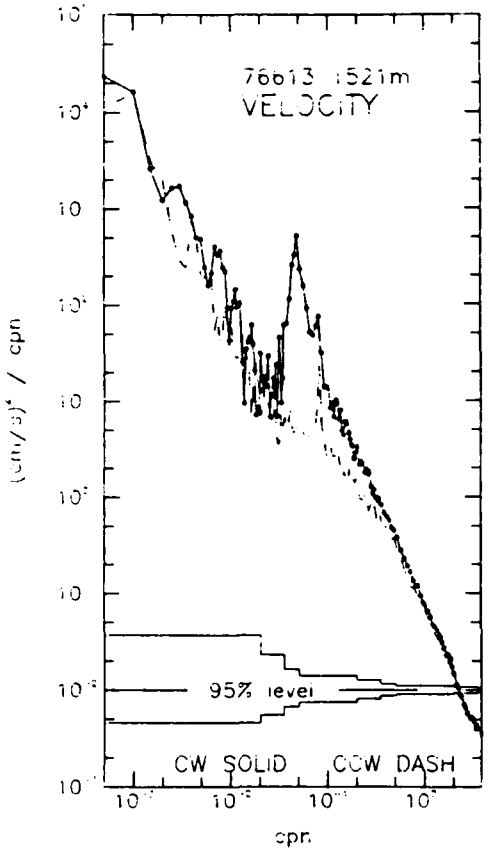

7652 1024m
PRESSURE
95% level
cpn

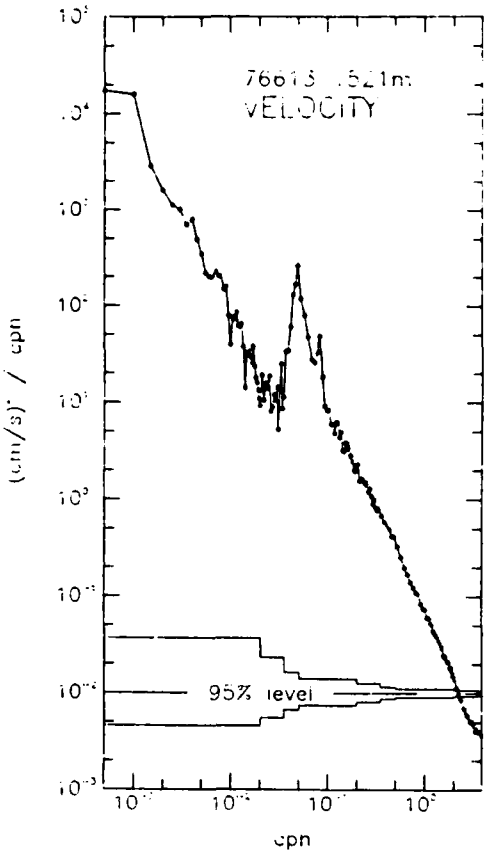

7652 1024m
TEMPERATURE
95% level

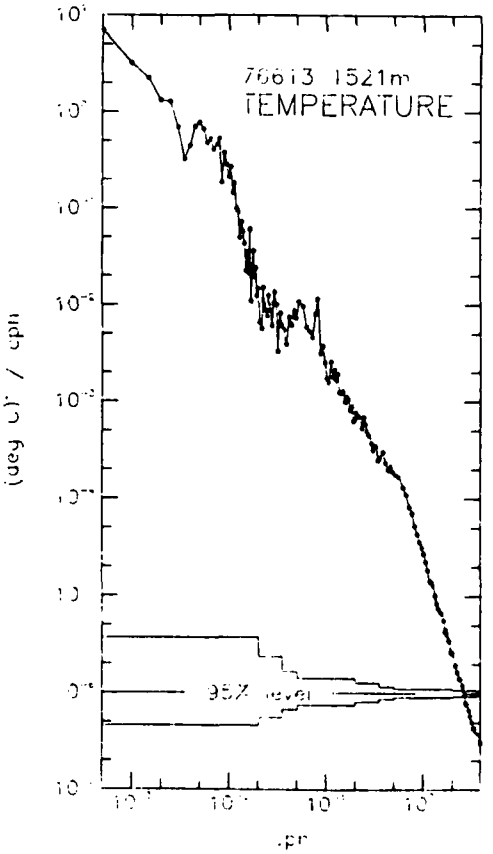

76612 1024m
VELOCITY
95% level
CW SOLID CCW DASH
cpn

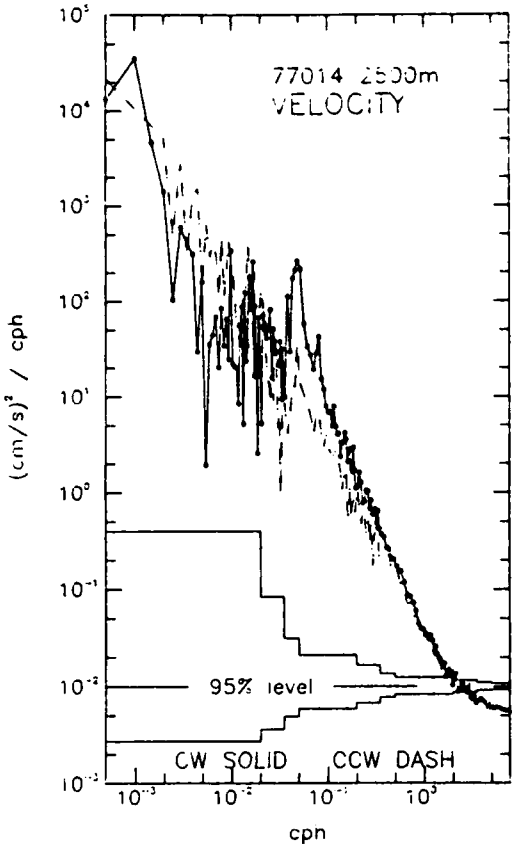

76612 1024m
VELOCITY
95% level
cpn

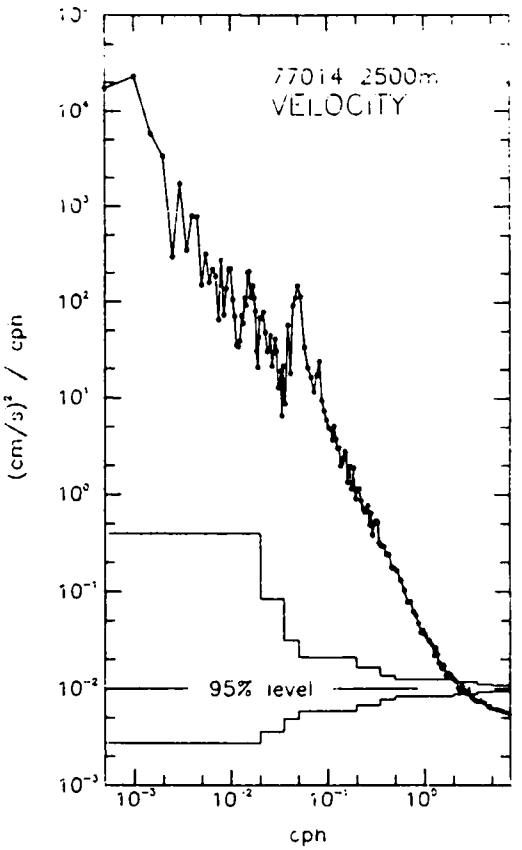

76612 1024m
TEMPERATURE
95% level
cpn

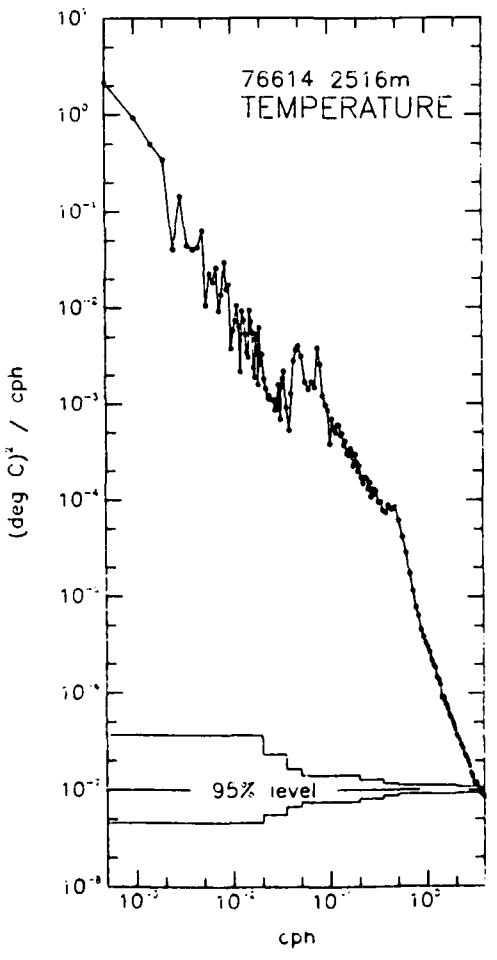

76613 1521m
VELOCITY
95% level
CW SOLID CCW DASH
cpn

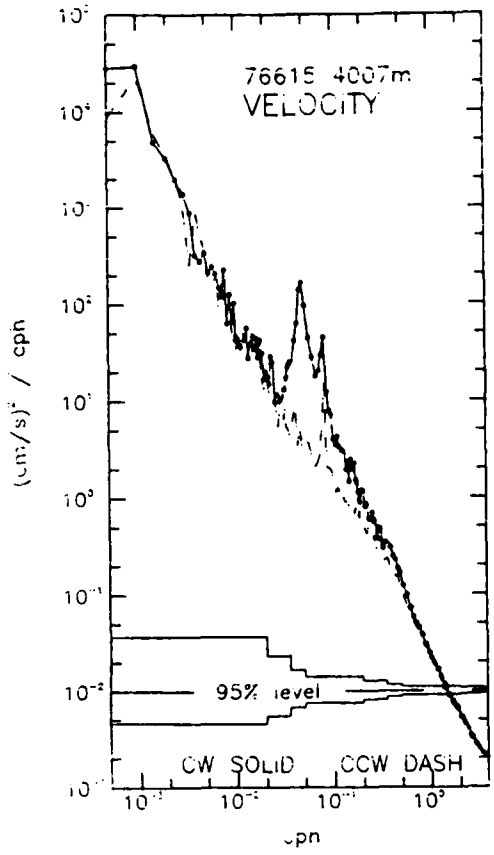

76613 1521m
VELOCITY
95% level
cpn

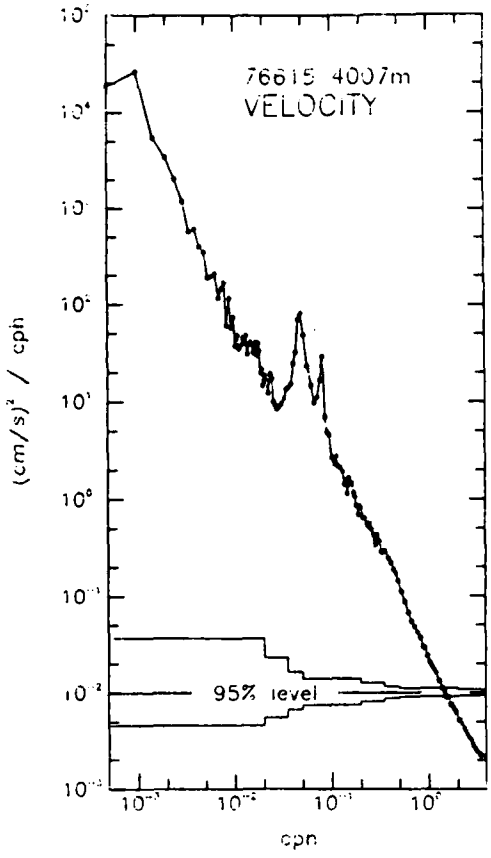

76613 1521m
TEMPERATURE
95% level
cpn

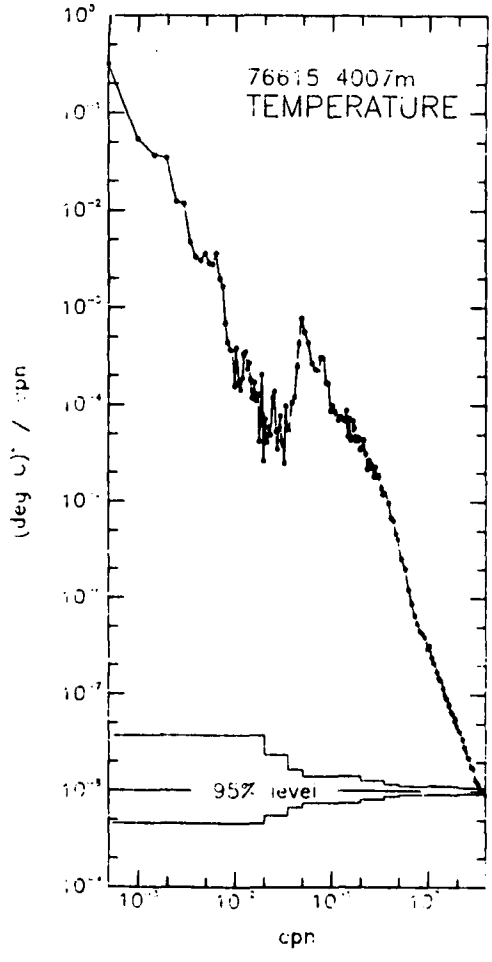

77014 2500m
VELOCITY
95% level
CW SOLID CCW DASH
(cm/s)² / cph
cpn


77014 2500m
VELOCITY
95% level
(cm/s)² / cpn
cpn


76614 2516m
TEMPERATURE
95% level
(deg C)² / cph
cph


76615 4007m
VELOCITY
95% level
CW SOLID CCW DASH
cpn


76615 4007m
VELOCITY
95% level
cpn


76615 4007m
TEMPERATURE
95% level
cpn

STATISTICS

METEROLOGICAL DATA

Mean

Data	EAST	NORTH	SPEED	SEA TEMP	AIR TEMP	INSOL	REL HUMIDITY	BAR PRESS
767S1	0.910	0.926	5.702	25.167	24.284	-	-	-
767S2	1.821	1.775	5.429	-	24.245	-	-	1016.514
770S1	0.559	-0.541	8.303	21.308	18.522	93.749	92.985	-
770S2	0.522	-0.564	8.705	-	19.662	-	-	1016.015

Variance

Data	EAST	NORTH	SPEED	SEA TEMP	AIR TEMP	INSOL	REL HUMIDITY	BAR PRESS
767S1	15.220	22.325	6.719	3.738	4.406	-	-	-
767S2	12.057	17.591	6.639	-	5.690	-	-	12.129
770S1	34.370	45.009	11.033	1.786	8.693	18451.223	119.053	
770S2	37.975	49.888	12.667	-	3.704	-	-	66.263

Skewness

Data	EAST	NORTH	SEA TEMP	AIR TEMP	INSOL	REL HUMIDITY	BAR PRESS
767S1	-.0898	-0.440	-0.744	-0.610	-	-	-
767S2	-.0827	-0.524	-	-0.242	-	-	-0.527
770S1	0.180	.0764	0.383	-0.592	2.022	-1.806	-
770S2	0.185	.0716	-	.0395	-	-	-0.598

Kurtosis

Data	EAST	NORTH	SEA TEMP	AIR TEMP	INSOL	REL HUMIDITY	BAR PRESS
767S1	2.550	2.731	2.578	2.717	-	-	-
767S2	2.663	2.959	-	2.425	-	-	2.721
770S1	2.281	2.109	2.096	3.023	6.465	5.338	-
770S2	2.299	2.124	-	2.770	-	-	2.944

Minimum Value

Data	EAST	NORTH	SPEED	SEA TEMP	AIR TEMP	INSOL	REL HUMIDITY	BAR PRESS
767S1	-12.798	-14.363	.0407	20.121	17.940	-	-	-
767S2	-10.120	-13.113	.0316	-	17.200			1007.084
770S1	-14.679	-17.813	.0599	19.312	8.211	10.339	53.147	-
770S2	-15.629	-18.837	.0255	-	15.190	-	-	989.224

Maximum Value

Data	EAST	NORTH	SPEED	SEA TEMP	AIR TEMP	INSOL	REL HUMIDITY	BAR PRESS
767S1	13.495	14.217	15.177	29.452	29.240	-	-	-
767S2	13.984	14.619	15.307	-	30.992	-	-	1023.795
770S1	17.081	16.732	18.387	24.266	24.587	782.091	102.362	-
770S2	18.085	17.171	19.311	-	27.352	-	-	1033.115

East and North

	COVAR.	CORR. COEFF.	ELLIPSE ORIENT	MAJAX	MINAX
767S1	4.833	.262	.282	26.842	4.977	3.574
767S2	3.471	.238	.266	25.718	4.389	3.223
770S1	1.538	.0391	.131	8.063	6.725	5.844
770S2	1.773	.0407	.133	8.287	7.081	6.141

		MEANS					Variance					Skewness			
Data	depth	EAST	NORTH	SPEED	TEMP	PRESS/TDIF	EAST	NORTH	SPEED	TEMP	PRESS/TDIF	EAST	NORTH	TEMP	PRESS/TDIF
m 7673	5	-17.890	-3.117	27.868	25.057		434.154	309.489	296.754	3.510		-.342	-.279	-.773	
m 7674	10	-16.391	-0.893	24.927	24.946		316.091	269.984	234.173	3.655		-.440	.0729	-.744	
m 7675	15	-15.203	-1.085	21.741	24.807		285.839	217.329	262.819	3.927		-.798	-.264	-.678	
a 7676	20	-19.695	0.654	28.135	24.691		360.791	315.727	273.252	4.218		-.312	.216	-.616	
m 7677	25	-17.565	-0.592	24.204	24.188		255.271	234.268	212.557	4.729		-.362	.198	-.404	
a 7678	35	-18.355	-0.768	23.752	23.245		231.611	205.040	209.984	4.849		-.419	.0298	.0777	
m 7679	50	-16.752	-0.148	21.162	22.229		199.481	148.873	181.191	5.142		-.409	-.0236	.539	
a 76710	65	-19.999	-1.246	25.316	21.524		212.916	202.075	175.588	3.783		-.0254	-.0780	.584	
m 76711	75	-15.642	-1.879	19.491	20.949		160.822	130.927	160.043	2.853		-.552	-.440	.665	
m 76712	100	-15.033	-3.273	18.417	20.023		144.548	113.731	155.804	1.343		-.632	-.913	.800	
m 7703	5	9.161	-5.079	22.551	21.296		370.344	269.821	241.343	1.782		.587	-.514	.384	
m 7704	10	8.446	-3.759	21.753	21.295		360.166	257.904	230.332	1.779		.646	-.583	.385	
a 7705	15	8.359	-3.386	22.298	21.281		391.906	266.923	242.947	1.776		.677	-.698	.388	
m 7706	25	8.128	-3.958	20.592	21.289		335.930	230.470	224.079	1.775		.564	-.864	.390	
m 7707	50	6.825	-2.447	19.976	21.276		337.822	222.855	214.185	1.747		.805	-.837	.387	
m 7708	75	11.951	-5.586	25.908	21.219		520.017	278.262	301.075	1.633		.336	-.612	.332	
m 7709	100	-	-	-	20.964		-	-	-	.935		-	-	.0174	
m 77014	2500	-1.287	0.697	6.444	-		36.230	18.477	15.328			-.915	.0622	1.539	
a 7641	527	-8.315	1.193	16.734	16.995	537.203	177.084	146.438	114.052	.253	284.402	.177	-.291	-1.898	4.133
a 7642	1024	-3.721	-0.185	9.405	7.537	1038.711	57.587	40.780	23.789	.421	241.861	.0691	-.136	-.148	4.033
a 7651	527	-7.156	-0.373	16.160	16.941	544.645	229.252	104.216	123.649	.292	222.499	.735	-.891	-1.942	3.302
a 7652	1024	-3.198	0.121	9.147	7.541	1051.011	58.068	39.955	24.593	.525	186.742	.0390	-.181	-.0536	3.197
a 7661	127	-6.531	-0.401	19.477	19.503	141.829	357.361	148.426	169.228	.690	748.822	.333	-.510	.474	3.248
m 7662	129	-6.364	-0.836	13.570	19.460		207.922	78.642	143.620	.647		-.252	-.636	.447	
a 7663	178	-6.241	-1.381	18.228	18.860	195.699	314.208	128.079	150.872	.197	750.522	.450	-.705	.278	3.237
D 7664	228	-6.594	-0.611	18.533	18.480	.894-2	320.665	134.218	155.239	.101	.133-3	.355	-.594	.424	4.804
a 7665	278	-6.840	-0.856	18.099	18.218	297.308	309.521	121.542	151.015	.0521	743.943	.454	-.718	-.206	3.257
D 7666	328	-6.703	-1.219	17.439	18.019	.360-2	287.046	113.172	142.519	.0424	.121-4	.517	-.676	-1.057	1.511
D 7667	427	-15.163	-2.127	17.368	17.576	.702-2	110.615	71.724	115.129	.110	.427-4	-.755	-.601	-2.573	2.842
D 76611	775	-4.646	.576	11.781	12.651	.0317	102.726	60.289	45.824	1.158	.371-3	.254	-.362	-1.414	.566
a 76612	1024	-2.441	0.437	8.630	7.543		53.846	35.725	21.237	.555		-.0703	-.0583	-.144	
a 76613	1521	-0.932	0.315	6.764	4.551		36.795	19.070	11.083	.0168		-.341	-.199	-2.024	
a 76614	2516	-	-	-	3.430		-	-	-	.283-2				.252	
a 76615	4007	2.030	1.068	7.876	2.403		48.172	20.272	11.674	.415-3		-.431	-.335	.0613	

		Kurtosis				Minimum Value					Maximum Value				
		EAST	NORTH	TEMP	PRESS/TDIF	EAST	NORTH	SPEED	TEMP	PRESS/TDIF	EAST	NORTH	SPEED	TEMP	PRESS/TDIF
m 7673	5	2.821	3.942	2.624		-87.149	-77.310	.118	20.023		39.849	49.181	94.667	27.823	
m 7674	10	3.211	4.499	2.596		-80.380	-78.210	.0417	19.839		30.675	68.344	92.839	27.607	
m 7675	15	3.611	5.438	2.444		-81.453	-79.818	.000	19.826		29.403	61.644	92.701	27.504	
v 7676	20	2.982	4.144	2.279		-84.570	-78.983	.115	19.815		31.778	75.775	95.236	27.510	
m 7677	25	3.052	4.265	1.894		-77.222	-73.108	.0417	19.559		28.179	63.606	86.565	27.426	
v 7678	35	2.789	4.148	1.693		-68.495	-60.257	.0902	19.479		22.835	58.983	77.382	27.285	
m 7679	50	3.020	4.621	1.746		-58.897	-53.190	.0417	19.225		25.842	57.312	69.490	26.936	
v 76710	65	3.022	3.540	1.813		-59.265	-56.179	.0934	19.108		30.952	54.275	70.140	26.901	
m 76711	75	2.866	4.663	1.981		-54.936	-53.145	.0417	18.945		18.601	48.901	65.558	26.157	
m 76712	100	2.753	5.364	2.450		-52.276	-56.059	.000	18.706		17.317	77.631	80.974	24.285	
m 7703	5	3.391	2.986	2.094		-49.341	-61.638	.0932	19.297		72.887	47.596	77.494	24.130	
m 7704	10	3.381	3.143	2.094		-46.502	-59.040	.186	19.302		70.205	45.322	75.617	24.115	
v 7705	15	3.363	3.390	2.097		-45.958	-62.199	.0545	19.295		73.318	47.920	78.691	24.088	
m 7706	25	3.318	3.575	2.096		-44.624	-54.625	.0833	19.112		67.188	35.087	70.389	24.088	
m 7707	50	3.531	3.645	2.079		-41.344	-54.170	.0417	19.310		63.651	35.977	68.181	24.074	
m 7708	75	2.154	2.782	1.957		-40.494	-51.614	.172	19.309		60.161	32.440	66.112	23.999	
m 7709	100	-	-	1.801		-	-	-	19.325		-	-	-	23.103	
m 77014	2500	4.112	3.121	-		-30.344	-11.415	.0417	-		10.565	19.805	30.347	-	
v 7641	527	3.783	7.100	8.373	22.781	-49.720	-61.696	1.098	14.266	528.302	49.864	56.201	64.451	17.878	679.169
v 7642	1024	2.938	3.895	2.504	21.704	-36.343	-35.477	.404	5.630	1028.630	28.498	28.944	40.382	9.204	1166.242
v 7651	527	4.873	5.113	7.603	15.263	-46.940	-52.216	.492	14.338	535.983	49.835	30.447	52.377	17.765	644.890
v 7652	1024	2.803	3.540	3.479	14.550	-27.699	-29.617	.284	5.564	1041.948	22.149	23.271	30.193	10.131	1142.575
v 7661	127	3.621	3.764	2.199	15.638	-54.438	-51.585	.0744	17.927	127.363	55.071	40.082	62.137	22.453	319.036
m 7662	129	3.902	4.612	2.137		-49.234	-34.425	.000	17.920	-	38.430	37.549	56.707	22.402	
v 7663	178	3.948	3.742	2.587	15.563	-48.486	-45.974	.217	17.762	181.093	52.221	34.791	58.448	20.011	372.989
D 7664	228	3.659	3.904	3.601	49.021	-51.756	-51.301	.403	17.607	-.0261	50.620	41.517	57.784	19.758	.253
v 7665	278	3.812	3.939	3.692	15.722	-48.553	-44.913	.140	17.352	282.757	49.151	33.989	58.346	19.304	474.270
D 7666	328	3.837	3.893	5.876	9.599	-45.172	-41.289	.0696	18.667	-.0125	47.484	30.751	54.833	18.667	.0375
D 7667	427	2.598	3.371	11.476	17.700	-44.673	-30.797	1.899	15.604	-.0226	9.451	19.942	49.741	18.116	.0869
D 76611	775	3.096	4.770	5.858	5.120	-32.255	-39.535	.478	8.331	-.0848	31.849	31.853	39.570	14.758	.205
v 76612	1024	2.756	3.596	3.456		-29.026	-26.890	.380	5.461		29.451	27.764	29.985	10.005	
v 76613	1521	2.464	3.074	12.619		-22.926	-16.325	1.314	3.598		15.466	14.124	24.926	4.861	
v 76614	2516	-	-	3.149		-	-	-	3.218		-	-	-	3.651	
v 76615	4007	2.449	2.827	2.792		-20.939	-16.933	1.410	2.344		19.266	13.698	21.187	2.489	

			EAST AND NORTH COVAR.	CORR. COEFF.	ELLIPSE	ORIENT	MAJAX	MINAX
m 7673E225	5	VM-1103	68.221	.186	.224	66.209	21.546	16.715
m 7674B225	10	VM20803	51.917	.178	.178	56.972	18.704	15.370
m 7675B225	15	VM-503	59.486	.239	.244	59.968	17.895	13.525
v 7676B225	20	V-5101	51.416	.152	.154	56.832	19.859	16.796
m 7677B225	25	VM20903	53.605	.219	.203	50.542	17.303	13.789
v 7678B225	35	V-5102	51.853	.238	.221	52.185	16.488	12.837
m 7679B225	50	VM-1003	53.271	.309	.297	57.704	15.269	10.733
v 76710B225	65	V-5110	59.050	.285	.255	47.622	16.334	12.174
m 76711B225	75	VM20703	47.638	.328	.300	53.710	13.993	9.795
m 76712B225	100	VM-1805	47.003	.367	.332	54.075	13.364	8.926
m 7703C225	5	VM042	-31.531	-.997-1	.171	106.051	19.478	16.148
m 7704C225	10	VM040	-31.150	-.102	.178	105.675	19.207	15.785
v 7705C225	15	V0433	-51.443	-.159	.222	109.731	20.257	15.763
m 7706D225	25	VM039	-61.791	-.222	.256	114.762	19.090	14.211
m 7707C225	50	VM037	-56.197	-.205	.255	112.176	18.993	14.140
m 7708D225	75	VM038	-152.732	-.402	.413	115.820	24.370	14.295
m 77014C225	2500	VM-043	7.480	.289	.364	69.941	6.242	3.968
v 7641B450	527	V-178P	-15.839	-.984-1	.128	112.974	13.557	11.820
v 7642B450	1024	V-195P	0.637	.131-1	.159	87.832	7.590	6.384
v 7651B450	527	V-179P	-20.299	-.131	.341	98.994	15.247	10.050
v 7652B450	1024	V-325P	-0.134	-.278-2	.171	90.424	7.620	6.321
v 7661B450	96	V-106P	-9.066	-.394-1	.357	92.480	18.914	12.167
m 7662B450	98	VM201003	1.590	.124-1	.385	89.296	14.420	8.867
v 7663B450	148	V-108P	3.969	.198-1	.362	88.779	17.728	11.313
D 7664B450	198	V-589	-22.900	-.110	.362	96.901	17.984	11.465
v 7665B450	248	V-109P	-9.913	-.511-1	.375	93.010	17.608	11.001
D 7666C450	328	DT5114	2.114	.117-1	.372	89.304	16.943	10.637
D 7667C450	427	V-591	28.470	.320	.328	62.167	11.209	7.529
D 76611B450	748	DT-5115	2.059	.262-1	.235	87.228	10.140	7.758
v 76612B450	1024	V-5113	1.460	.333-1	.188	85.423	7.346	5.967
v 76613B450	1498	V-5106	0.758	.286-1	.281	87.556	6.068	4.363
v 76615B450	3998	V-661	4.284	.137	.366	81.464	6.987	4.430

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LOTUS was a two-year experiment near 34°N, 70°W, designed to acquire and analyse a continuous set of measurements of currents and temperatures in the upper, open ocean together with local hydrography, meteorology, and mesoscale oceanographic features. The first scientific moorings were deployed in May 1982. The first year of mooring data, from May 1982-April 1983, is presented here.

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